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PRINCIPLES OF SURGICAL PRACTICE

WATER AND SALT METABOLISM

SAMUEL STANDARD, M.D., F.A.C.S., New York, New York

MEDICINE has been taught in various ways. Arbitrary classifications have been set up for purposes of convenience, the convenience of teaching, of investigation, or of therapy. We now have systems of medicine with gross divisions into pulmonary, gastro-intestinal, and genito-urinary diseases, each system being treated as an entity in itself. Hutchins (41), in his address before the American College of Surgeons, pointed out that the whole is not always the sum of its parts. With this truism in mind, it might not appear illogical to teach medicine in terms of fundamental derangements seen in a cross section of all systems affected. Derangements in the mechanisms that control the constant factors in the body offer such an approach to the study of medicine. Of greatest importance to the well being of the body is the maintenance of a constant internal environment. The concept of the constancy of the internal environment first advanced by Claude Bernard has been amply substantiated by Cannon and his co-workers (12). Among the so-called steady factors in the body is the effort it exerts to maintain a constant ratio between the fluids and solids of which it is composed.

The wealth of recent literature that has sprung up on the subject of water metabolism may be taken as an index of our growing understanding of its importance in the proper functioning of living matter. The basic nature of the problem may be inferred from the diversity of interests focused upon it. The chemist and the physiologist have clarified some of the details of the intrinsic mechanisms utilized by the body in the handling of water in the normal state and in the abnormal states of water loss, deprivation, or overabundance. The medical clinician and the surgeon have been learning to apply this newly acquired knowledge at the bedside and in the operating room.

The subject is a large one, so for purposes of clarity it will be treated under a classification which will have the advantage of isolated discussion of each principle involved with the recent literature supporting it.

GENERAL OUTLINE

1. The normal water content and its relationships in the body
2. Clinical diseases in which salt and water derangements contribute significantly to the morbidity or mortality of the underlying disease, and the physiological mechanisms underlying each type of derangement
3. The intrinsic compensatory efforts of the body to maintain the "constant factors" in water and salt relationships; the rôle of the lung, gastro-intestinal tract, and kidney, in the normal and in the above derangements. What circumstances are responsible for failure of the intrinsic mechanisms and what are the principles involved in replacement therapy when intrinsic efforts fail?
4. Details in materials, methods, and mechanics used in replacement therapy and indications for their use
   a. Materials: blood, water, glucose, saline solution, acacia, Ringer's solution, Hartman's solution and lyophile
   b. Routes: mouth, rectum, and subcutaneous and intravenous routes
   c. Mechanics, duodenal tube and rectal tube
      Forms of containers, and dispensers for clysis and infusion
      Speed, temperature, duration of infusions, and amount

5. Complications following parenteral therapy
   a. Chill, fever, local infection, and phlebitis
   b. Water retention and edema (pulmonary, serous, skin) due to salt retention, protein loss, and capillary paralysis
   c. Methods of overcoming retention of fluids; administration of distilled water, hypertonic glucose or sucrose solution, transfusions, and acacia
6. Conclusions

The importance of maintaining a constant water balance is appreciated when the effect of the deprivation of water is compared with that of food. In starvation (66) an animal can lose 40 per cent of its weight as protein and all of its glycogen and fat, and still live; whereas the loss of 10 per cent of its water content results in serious disorders, and a loss of 20 per cent in death.

THE NORMAL WATER CONTENT AND RELATIONSHIPS IN THE BODY

For purposes of discussion this subject will be divided into three parts: the fluid-solid ratio, normal fluid 70 per cent; the water-salt ratio, normal equivalent .85 per cent sodium chloride; and the acid-base balance, normal pH 7.4.

The fluid-solid ratio. The water content varies for different tissues and for the same tissue under differing metabolic activities or exposure to changing temperatures (5). For the body as a whole, "this too, too solid flesh" of Hamlet's is not nearly as solid as he thought, being only 30 per cent solid and 70 per cent fluid. This 70 per cent is distributed in three large reservoirs as indicated in Figure 1. Note that only 5 per cent of the body weight consists of blood plasma, 15 per cent of extracellular or interstitial fluid, and 50 per cent of intracellular fluid. Note, too, that there is no irreversible intake of fluid, but there are four irreversible avenues for loss of fluid, namely, the intestinal tract, evaporation by way of the lungs, insensible perspiration and sweating by way of the skin, and elaboration of urine by way of the kidneys.

The intake is supplied by ingestion and alimentary absorption. The amount of fluid taken is determined by a vague reflex we term pharyngeal thirst. Nowhere is the delicate balance of intake and output better demonstrated than in the matter of fluid ingestion, distribution, and excretion.

A second source of fluid is that produced by the oxidation of hydrogen within the body. The reaction of the complete combustion of a carbohydrate molecule demonstrates this source.

$C_6H_{12}O_6$ plus $6O_2$ equals $6CO_2$ plus $6H_2O$

This water of oxidation differs for each type of food metabolized (15). The oxidation of 1 gram of protein yields 0.4 gm. of water; of carbohydrate 0.6 gm., and of fat 1.07 gm. of water. It happens that oxidation produces water nearly in proportion to the calorific value (1); it yields from 10 to 15 gm. of water per 100 calories. Thus on an average 2,500 to 3,000 calorie daily diet, the water of oxidation would contribute from 250 to 450 gm. of water a day. Although not a large amount, it becomes important in starvation such as occurs postoperatively and should be taken into account in replacement therapy.

The avenues for the excretion of fluid are indicated in Figure 1.

Urinary excretion amounts to approximately 1 c.cm. of water a minute or a total of some 1,500 c.cm. a day. The minimum fluid requirement by the kidney for adequate excretory function is determined by its ceiling of concentrating power. The last stand of a failing kidney is its ability to put out a large volume of urine at a fixed low specific gravity. In such a case mere volume output is no index of adequate excretory function. Thirty-five grams of waste product are brought daily to the kidney for excretion. A normal kidney which can concentrate to a specific gravity of from 1.030 to 1.035 requires a minimum of 600 c.cm. of finished urine a day for adequate function. Alteration of the acid-base balance may occur and blood retention of waste products does occur when the urine flow falls below 600 c.cm. a day for several days. In states of dehydration the urine flow falls significantly, and functional kidney failure is an important contributing factor in morbidity and may be a critical factor in mortality.

Pulmonary excretion of water. The expired air carries away as much water as is required to saturate it at body temperature. Normally this amounts to about 300 c.cm. a day.

Fecal loss of water is trivial, rarely exceeding 200 c.cm. a day.

Insensible cutaneous evaporation. This is not the same mechanism as sweating. Insensible cutaneous fluid loss is calculated from 1,000 to 1,500 c.cm. a day. Adolph (1) places the maximum as below 1,000 c.cm. and states that limitation of water intake, or dehydration appreciably diminishes this amount. Coller and Maddock in more recent work (13, 48, 14) find this loss a fixed quantity, relatively little affected by states of dehydration.

Sweat. Sweat glands are inactive under basal conditions, and function mainly as an emergency measure for heat loss during exercise, or exposure

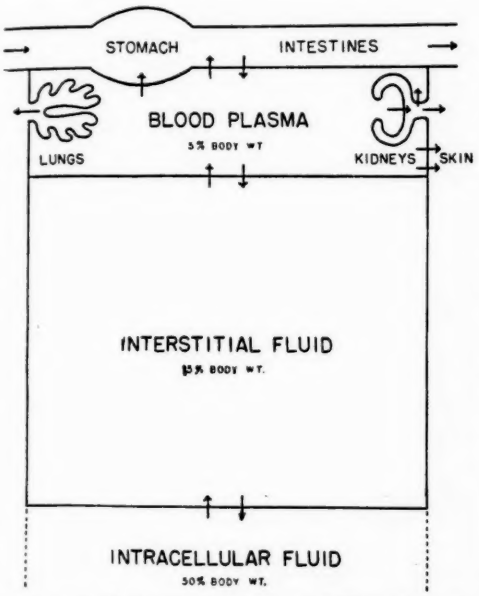

Fig. 1. The fluid reservoirs of the body illustrating avenues of fluid intake and loss. From Gamble (16).

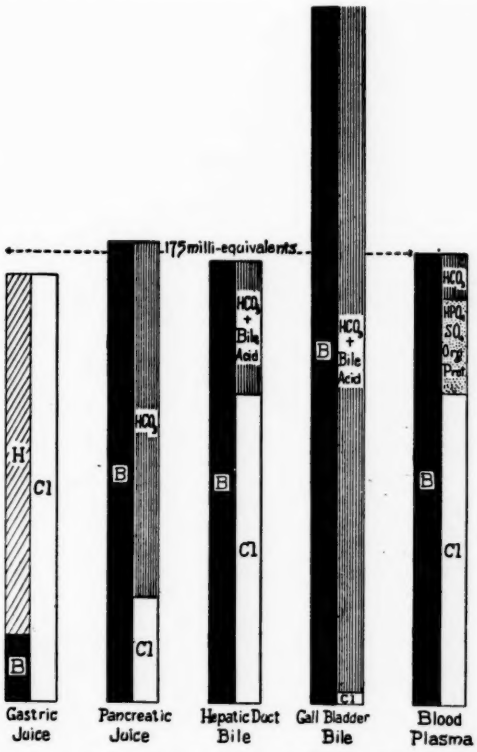

Fig. 2. Inorganic composition of digestive juices, illustrating the similarity of the total electrolyte concentration of all except gall-bladder bile to that of plasma. From Gamble and McIver (13).

to heat. This abnormal loss of water, as will be pointed out later, may reach critical heights. Men, working in hot environments, have been known to lose from 8 to 10 liters of water a day by this route.

In normal states, the water intake may be considered adequate if it reaches 3,500 c.cm. a day. This allows 1,500 c.cm. for urine and 2,000 c.cm. for insensible cutaneous loss.

The water-salt ratio. The heading just discussed was called the fluid-solid ratio. The word "fluid" was used rather than "water," since the tissues cannot handle, and do not come in contact with, distilled water, but rather with a fluid having dissolved in it definite concentrations of colloids in the form of proteins and crystalloids. The ratio between solvent and solute is carefully maintained at a constant value, and even small alterations in this constant produce marked derangements in physiological function. The most important step forward in our understanding of the chemical anatomy of the body fluids was taken by Gamble and McIver (27, 28) when they demonstrated the almost identical chemical structures in the blood plasma and the interstitial fluid, the similarity in ionic concentration to intracellular fluid, and the very close resemblance of the gastro-intestinal secretions to both of these (Fig. 2). The predominating base in extracellular fluid is sodium; in intracellular fluid, potassium. However, the ionic concentrations of each is similar to the other. The ionic concentration is the equivalent of an .85 per cent sodium-chloride solution. This has been called "physiological saline." The other crystalloids each play a rôle in plasma, but quantitatively the sum of all the rest constitutes less than 10 per cent.

Smith (71) points out that the kidney has more to do with the maintenance of a constant concentration of dissolved substances in the plasma than with mere volume changes in it; i.e. it is more the custodian of the water-salt ratio than the fluid-solid ratio.

The acid-base balance. With the introduction of the salts in solution, a third inescapable factor presents itself for consideration, namely, the con-

trol of the acidity or alkalinity of the fluid medium. It is beyond the province of this paper to go into the chemical details responsible for the alterations in the acid-base balance. Suffice it to say that the normal hydrogen-ion concentration, pH 7.4, is maintained by the constant relationship of the bicarbonate ion to the carbonic acid. Under normal circumstances this ratio is provided by a plasma concentration of 3 volumes per cent carbon dioxide as free carbonic acid, and 60 volumes per cent as bicarbonate. As long as this 1 to 20 ratio is maintained the pH remains unchanged.

Theoretically, changes may occur in the concentration of either bicarbonate or carbonic acid. The concentration of free carbonic acid is controlled by the respiratory mechanism, and so excellent is this control that abnormalities due to an incorrect concentration of carbonic acid are almost never encountered. Dislocations in the direction of acidosis or alkalosis are almost always due to changes in the bicarbonate ion. Such a change in the bicarbonate ion is an event which is always secondary to a change in some other part of the electrolyte structure. Gamble (25) speaks of the "mendicant" position of bicarbonate, since its value depends on the extent to which the fixed base stands above the sum of the concentration of the other acid radicals. One can almost visualize bicarbonate in the pose of mendicancy, head bowed, palm upturned, never knowing whether it will receive alms or be deprived of the little it possesses, and yet having no independence of action or redress in either instance.

Figure 3B shows this plainly. When acids increase, be they chlorides, sulfates, phosphates, ketone acids in diabetes or starvation, or lactic acid in muscular exercise, they deprive bicarbonate of base (sodium) and produce an acidosis. Bicarbonate is converted to carbonic acid, which breaks up into carbon dioxide and water, and the former is excreted by the lungs.

When acids decrease, Figure 3C, the base stands above the sum of the concentration of the other acid radicals; it unites with carbonic acid and extends the bicarbonate range with a resultant alkalosis. When the base is lost (Fig. 3D), there is a contraction of the entire electrolyte structure, mainly at the expense of the bicarbonate ion, and an acidosis is produced.

Van Slyk (75) emphasizes the important rôle of bicarbonate and carbonic acid as neutralizing buffers against sudden changes of plasma pH by the accession of strong acid or alkali. Such neutralization is not complete in the sense that the pH of the solution does not remain entirely unchanged. The fact that acidosis and alkalosis develop is ample proof of this. Yet the change achieved is only a small fraction of what it would be if strong acid or alkali was added to an unbuffered solution. The equations below demonstrate the conversion of such strong acids and alkalies to weaker ones. Hydrochloric acid is changed to carbonic acid and sodium hydroxide to sodium bicarbonate.

$NaHCO_3$ plus HCl equals H_2CO_3 plus NaCl

H_2CO_3 plus NaOH equals $NaHCO_3$ plus H_2O

In the maintenance of the acid-base balance, the two most important organs are the lung and kidney. The hydrogen-ion concentration is in part regulated by respiration, but, as will be shown later, the kidneys contribute to this regulation by secreting variable quantities of bicarbonate and a more or less alkaline urine. In addition, when non-volatile acids are produced during acidosis, ammonia is formed for their neutralization in order to conserve the inorganic bases of the blood. Smith (71) states, "One might say that it was only incidentally in the performance of these complex tasks of conservation and regulation that the kidneys carry out their most obvious function, the excretion of the numerous products of metabolism."

CLINICAL DISEASES INVOLVING LOSS OF SALTS AND FLUIDS

These diseases will be considered under three headings: loss of fluid directly from the blood stream, as in hemorrhage and shock; loss of fluid by way of the gastro-intestinal tract; and loss of fluid due to metabolic derangements.

Loss of fluid directly from the blood stream. There is the obvious loss of fluid from the vascular bed associated with hemorrhage and the less obvious loss of fluid from the vascular bed associated with shock. In speaking of hemorrhage there will be included only the sudden severe hemorrhage such as occurs with external trauma and rupture of the large vessels which bleed to the exterior, ruptured ectopic pregnancy, a ruptured spleen, or an ulcer on the posterior surface of the duodenum which erodes through the pancreaticoduodenal artery. The slower oozing from bleeding hemorrhoids or bleeding uterine fibroids is not included in this group.

In hemorrhage there is a loss of whole blood. The intrinsic compensatory mechanisms involve an increased heart rate to compensate for the decreased stroke volume, and a peripheral vasoconstriction in an attempt to fit the vascular bed

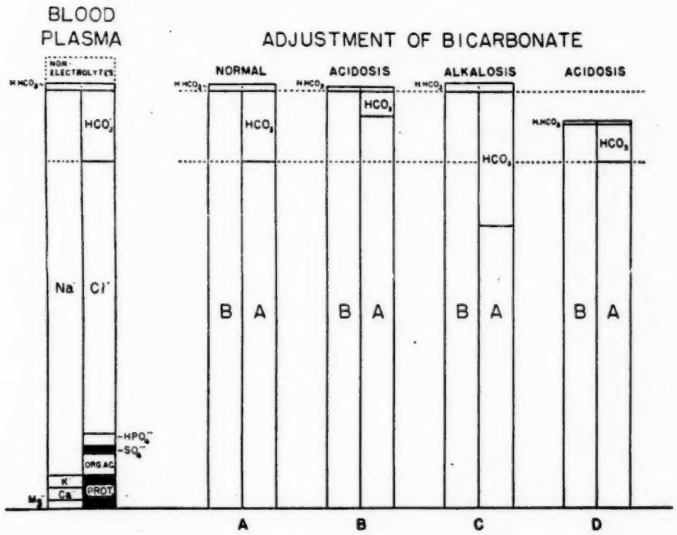

Fig. 3. Illustrating the "mendicant" position of bicarbonate in derangements in the acid-base balance. From Gamble (16).

to the new and reduced blood volume. If that were all of the mechanism involved it would be difficult to explain the constant finding of a reduced red blood count and hemoglobin in hemorrhage. Yet these are always found. The answer to this is best demonstrated when a dog is bled rapidly after his blood volume has been calculated. It is found that within a period of from one-half to one hour one can bleed from 2 to 2½ times the calculated volume. The latter blood, however, can be readily recognized as being only highly diluted water with a tinge of red in it, i.e., the vascular bed has absorbed fluid from the surrounding tissue to increase the blood volume. Since the loss has been blood and the replacement saline solution, the cellular elements per unit volume have been reduced and give the characteristic blood picture.

Clinically the patient in shock and the patient in hemorrhage cannot be differentiated. Both are pale, air hungry, and usually conscious, and both have a rapid, thready pulse and an unobtainable blood pressure. Yet the one laboratory finding mentioned above will help differentiate pure hemorrhage from pure shock. In shock there has been a loss of circulating blood volume and the blood has been pooled in the capillary bed because of a capillary paralysis. The arterioles are constricted and although there has been no loss of whole blood out of the vascular bed the stagnation of blood in the capillaries reduces the circulating blood volume.

The blood count in such a case is found to be high, either normal or above normal. The answer to this hemoconcentration lies in the added derangement in the fluid content of the blood. Either because of the capillary paralysis or perhaps the same factor which produces the capillary paralysis (histamine?) has also changed the permeability of the capillary wall, there has been an exudation of fluid from the vascular bed into the surrounding tissue which left behind a more concentrated blood. The loss is not whole blood but serum. Thus, a simple laboratory test differentiates the two diseases when they occur as separate entities, a differentiation impossible by ordinary clinical examination. This differentiation is of more than academic interest since, for example, a case of ruptured spleen bleeding into the peritoneal cavity must be differentiated from traumatic shock without hemorrhage, because in the former operation is inevitable, and in the latter it may prove fatal.

The shock syndrome should be limited in its definition, if it is to be retained as a distinct entity. The indiscriminate use of the term has robbed it of its original significance. Certain criteria should be fulfilled to warrant its use;

these criteria are as follows: (1) capillary paralysis, (2) arteriolar competence, (3) hemoconcentration, and (4) circulatory collapse of peripheral origin.

Heuer and Andrus (39), Sweet (74), and Scudder (68, 69) have demonstrated the rôle played by the adrenal cortical hormone in states of shock associated with dehydration, demineralization, toxemia, and hyperpotassemia seen in acute intestinal obstruction. They advise its use as an aid in treatment.

Moon (51, 52, 53) discusses the shock syndrome from the viewpoint of its edema-producing and hemoconcentrating tendencies. His work on pulmonary edema following capillary injury by various agents suggests the possibility of local shock in isolated capillary beds.

Phemister (60) emphasizes the importance of psychic and intrinsic reflex trauma as a purely neurogenic cause of shock. He recalls the instances of patients who insisted they would die if operated upon, and then keep their promise; although there was no organic evidence to warn the surgeon of such an outcome, these patients died in circulatory collapse with a typical shock syndrome. (We have seen mild shock incident to dehydration in intestinal obstruction markedly aggravated by the administration of a spinal anesthesia. This demonstrates the importance of arteriolar competence in the true shock syndrome. With the administration of spinal anesthesia the vasomotor spasm which constitutes one of the compensatory mechanisms for maintenance of the circulatory adequacy is abolished. Neurogenic vasomotor paralysis is added to preexisting volume loss. Complete collapse follows and death may result. In dehydration states, with circulatory competence already threatened by a diminished blood volume, spinal anesthesia may contribute a dangerous and often lethal component to circulatory collapse.) Phemister mentions, too, the fall in blood pressure so often seen in gall-bladder surgery. Burstein and Rovenstein (11) discuss this clinically, and experimentally prove it to be a reflex from the celiac ganglion which is markedly aggravated by atropin premedication.

Blalock (5, 6, 7, 10) offers experimental and clinical support for the theory that shock follows the blood loss by hemorrhage into damaged tissue through injured or leaky vessels. This would fail to explain the shock seen in acute pancreatic necrosis or ruptured peptic ulcer.

The treatment of hemorrhage and shock will be discussed later in relation to the various fluid media available. The specific drug therapy is beyond the province of this review, and will be mentioned briefly. Adrenal cortical hormone suggested by Heuer, Scudder, and Sweet (39, 68, 69, 74) has been discussed. Blalock (6, 7) warns against the use of vasoconstrictor drugs in shock except that caused by vasodilatation. The use of sympathicomimetic drugs, such as adrenalin and ephedrine, would tend only to further constrict an already adequately constricted arteriolar bed. Adrenalin in pharmacological doses produces hemoconcentration; in toxic doses it can produce the typical shock syndrome. Johnson (44) suggests the use of neosynephrin hydrochloride in the treatment of hypotension and shock from trauma or hemorrhage.

Loss of fluid by way of the gastro-intestinal tract. The investigations of Gamble (27, 28, 29, 32) have contributed immeasurably to our understanding of the derangements in the water and salt metabolism occurring in gastro-intestinal diseases. Gamble's basic contribution was the demonstration that the total electrolyte concentration per unit of water in all the gastro-intestinal secretions is approximately the same as in the blood serum. These secretions differ from serum and from each other in the varying proportions of individual ions which they contain. Figure 2 demonstrates this.

The source of water and salt loss in derangements of gastro-intestinal function can be easily appreciated if one adds up the total volume of secretions poured into the intestinal tract by the various intestinal juices. This averages from 8 to 10 liters a day.

In the diagram of the intestinal tract three lesions have been chosen. The first is pyloric occlusion; the second, duodenal fistula; and the third, a fistula of the ileum near the ileocecal valve.

The earliest recorded opinion on the importance of water and salt loss in diseases of the gastro-intestinal tract is quoted by Atchley (2). It is a report by O'Shaughnessy during the cholera epidemic in England in 1831. His summary merits repetition here:

"1. The blood drawn in the worse cases of the cholera, is unchanged in its anatomical or globular structure.

2. It has lost a large proportion of its water, 1,000 parts of cholera serum having but the average of 850 parts of water.

3. It has lost also a great proportion of its neutral saline ingredients.

4. Of the free alkali contained in health serum, not a particle is present in some cholera cases, and barely a trace in others.

5. Urea exists in the cases where suppression of urine has been a marked symptom.

6. All the salts deficient in the blood, especially the alkali or carbonate or soda, are present in large quantities in the peculiar white dejected matters."

His suggestions for therapy are equally direct, "First to restore the blood to its natural specific gravity (i.e. its water content); second, to restore its deficient saline matters..... the first of these can only be affected by absorption, by imbibition, or by the *injection* of aqueous fluid into the veins; the same remarks, with sufficiently obvious modifications, apply to the second."

Only a short period removed from the age when all diseases could be cured by "blood letting" this wise physician suggests the diametrically opposite procedure of intravenous infusion. Yet a lapse of eighty years intervened before Rogers and Nichols and Andrews used intravenous saline injections with a remarkable decrease in the mortality in the 1909 cholera epidemic in the Philippine Islands.

In Figure 4 the six sites lettered represent (a) pyloric occlusion, (b) duodenal fistula, (c) intestinal obstruction, (d) occlusion or fistula near the ileocecal junction, (e) tumor of the right side of the colon, and (f) tumor on the left side of the colon or in the sigmoid or rectum.

Dehydration with alkalosis (Fig. 4a). Pyloric occlusion with vomiting of the gastric secretion and food ingested is seen classically in the congenital hypertrophic pyloric stenoses in infants, in cicatricial contraction of a pyloric ulcer, or in occlusion of the pylorus by a malignant growth. Functionally, the same derangement is produced without an organic occlusion, by persistent vomiting in the toxemias of pregnancy, in sea sickness, or in terminal uremia.

Hollander (40) has shown that hydrochloric acid is secreted by the stomach at a constant concentration of about .4 per cent. Bulger (8) demonstrated the significant fact that the chloride in venous blood from the stomach differed little from that in arterial blood going to it; i.e. chloride and water are removed from the blood for the gastric juice in equivalent amounts. The base concentration in venous blood, however, greatly exceeds that in arterial blood.

Obstruction at the pylorus results in vomiting of the gastric contents containing some sodium, but far more chloride. (Only in cases of complete achylia, as in pernicious anemia, and in some cases of gastric carcinoma with achlorhydria does the loss of sodium equal the loss of chloride). As the elements in gastric secretion are derived from the body, the result to the organism is the loss of large amounts of water and chloride with a lesser quantity of sodium. The remainder of the sodium which was previously combined with chloride is liberated to combine with carbonic acid to form bicarbonate. Consequently the alkali reserve in the plasma increases while the plasma chloride diminishes and a condition of primary alkali excess is produced. There is a rise in the pH. The latter may rise from its normal (7.3 to 7.5) to 7.6 or higher and gastric tetany may appear. This is one of the few instances when ketosis due to starvation is associated with alkalosis.

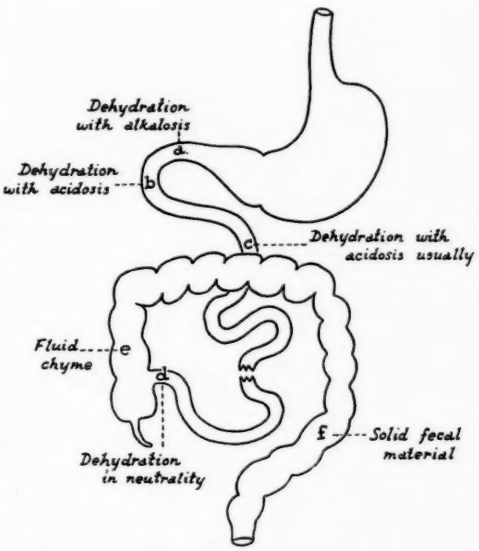

Fig. 4. Illustrating (a) pyloric obstruction; (b) duodenal fistula; (c) intestinal obstruction in the midjejunum or ileum; (d) fistula at the terminal ileum; (e) cecum and ascending colon; (f) rectosigmoid.

Donovan's (18) report on a series of cases of congenital hypertrophic stenosis in children clearly shows the importance of the recognition and treatment of the dehydration and alkalosis in this disease. The reduction in mortality is dramatic after the institution of replacement therapy along with the usual surgical procedure, the mortality falling from 25 per cent to practically 0.

Yet to this day patients with pernicious vomiting of pregnancy are being given sodium bicarbonate for the "acidosis" supposedly present. This can only aggravate the existing alkalemia.

When the deprivation of water and chlorides is not marked the normal compensatory mechanisms, to be discussed below, may succeed in restoring the original status; when the loss is great, treatment must be instituted to restore the water and salt balance. (It is analogous to the results of hemorrhage. Up to a certain critical loss, compensatory mechanisms such as an increased heart rate, constriction of the peripheral vessels, or shunting of the blood to vital organs may suffice to maintain the required blood pressure. Beyond this point transfusion becomes indispensable. So, in the matter of salt and water loss.)

Dehydration with acidosis. Figure 4b indicates the derangement due to a duodenal fistula with loss of highly alkaline pancreatic juice. The classical experiments have been made by Hartman and Elman (34) and Gamble (28, 25): canalization of the pancreatic duct with complete removal of the external pancreatic secretion was performed. The loss is mainly base bicarbonate, and a preponderance of acid radicles is left. The plasma changes were uniformly characteristic with a persistent base-bicarbonate and water loss. The plasma volume as compared to cell volume decreased enormously, sometimes being only one-fourth of the total blood volume instead of the normal one-half. Completely depancreatized dogs live for years under proper diabetic control with insulin. The death of these dogs cannot, therefore, be attributed to the absence of pancreatic juice, but rather to its elaboration and loss with the resultant dehydration and acidosis.

The loss of bile, even with a complete biliary fistula, is usually well borne. Bile, though a well buffered secretion, is only mildly alkaline in reaction and its loss entails no appreciable disturbance in the acid-base balance or water loss. It contains no digestive enzymes, yet its importance in fat digestion is seen in the clay-colored stools when bile is excluded from the intestinal tract. Some 90 per cent of fat fails to be digested and is excreted as such. Added to this there is an excretion of fat into the intestinal tract by the blood stream (as recently shown by Shapiro and his co-workers (70)). Ivy's (42) work indicates the importance of the loss of fat Vitamins A and D in the production of the hemorrhagic tendencies in jaundice, and suggests the administration of the vitamins to overcome such tendencies.

Dehydration in neutrality. Figure 4a demonstrates a lesion near the ileocecal junction associated with a low ileal fistula. The loss is water and neutral salt. The acid-base balance is maintained as a rule. Dehydration and neutral demineralization are the important factors in this lesion.

Acute intestinal obstruction involving the small intestines below the pylorus (Fig. 4c) produces derangements in the water and salt balance that vary and depend upon the site of obstruction. The lower in the alimentary tract the obstruction occurs, the less specific is the tendency toward reduction of chloride or the rise of carbon dioxide because of the fact that the fluid contains a relatively larger admixture of alkaline intestinal secretions.

A frequently overestimated source of comfort to the physician is the absence of vomiting in intestinal obstruction. Gamble (30, 31) has shown that the fluids contained in the distended and non-absorbing intestinal tract, even in the absence of vomiting, will account for the blood changes found in such instances. The mere absence of vomiting is no insurance against marked dehydration and acid-base derangements. The fluid that is contained in the intestinal tract from overdistention in paralytic ileus cannot be absorbed and must be considered for all practical purposes as being outside of the body.

The cause of death in intestinal obstruction has been variously ascribed to a variety of factors. Sweet (74) ascribes it to adrenal cortical failure, as he believes that the loss of water, the loss of sodium chloride, the blood concentration, and the increase in non-protein nitrogen are all secondary manifestations. Scudder (67, 68, 69) believes that death is due to the rise in potassium which he has demonstrated in intestinal obstruction. He attributes the potassium rise to a combination of dehydration, tissue breakdown, and the action of bacterial toxin with consequent adrenocortical and renal dysfunction resulting in inadequate potassium elimination. He demonstrates adrenal pathology in cases of acute intestinal obstruction. Atchley (3) believes the dehydration, demineralization, and dehydration shock amply explain the mortality in this disease. Gatch (33) reviews many of the causes suggested. They include a toxin elaborated by a perverted secretion of the intestinal epithelium, the effect of the pancreatic enzyme on the proteins present in the duodenum, and the production of histamine and allied proteolytic products by the action of putrefactive bacteria in the involved segment.

In a disease such as acute intestinal obstruction there is so wide a variety of derangements that it is extremely hazardous to pick out one

and attribute to it the lethal effects. Infection, toxemia, starvation, ketosis, dehydration, demineralization, hyperpotassemia, azotemia, and alterations in the acid-base balance, as well as the uncertainties of anesthesia, and the dangers of a major surgical procedure come up for consideration. It would be more reasonable to assume that each adds its quota to the morbidity, or to the final mortality, rather than to pick out one of the many and say, "there is the culprit responsible for death."

Although there is a great difference of opinion as to the cause of death, there is a fair unanimity on the therapeutic principles involved in the treatment of the disease. All agree that the replacement of water and salt to overcome dehydration and demineralization, and the addition of glucose to overcome ketosis may prove life-saving measures.

The tumors in the colon are included only to emphasize the importance of the colon as a water-absorbing organ. From 7 to 10 liters of fluid are poured into the intestinal tract by the various digestive secretions. It is the duty of the colon to retrieve all but from 200 to 300 c.cm. lost in the feces. When the chyme enters the cecum it is in a fluid state. A tumor on the right side of the colon (Fig. 4e) may encroach upon the lumen almost to complete occlusion and yet give no sign of obstruction since the fluid chyme flows easily past the obstruction. One rarely sees acute intestinal obstruction with tumors on the cecal side. In the sigmoid and rectum (Fig. 4f) even minimal occlusions of the lumen encounter the solid fecal content; obstruction and bleeding are early symptoms; and a tumor on the right side may produce all the general signs of advanced malignancy before producing any local signs of its presence.

Loss of fluid due to metabolic derangements. A good example of water loss as a result of disease is seen in diabetes mellitus. Admittedly a derangement in the carbohydrate metabolism, water loss in glycosuria, in ketosis, and in impending coma becomes a major factor in morbidity. The diabetic patient in ketosis loses water because of two unrelated factors. The ketone acids require neutralization by a base to be excreted as salts. With the excretion of this base goes a fixed amount of body water. The second cause is associated with glycosuria. The reason for this loss is not completely understood. The theory that a highly glucose-laden glomerular filtrate exerts sufficient osmotic tension in the lumen of the tubule to prevent water reabsorption is not tenable. If the glomerular filtrate has the same concentration as the plasma, then the glucose content on the vascular side of the tubule is exactly the same as on the lumen side, and leaves no osmotic advantage, so far as the effect of the glucose is concerned, on the lumen side of the tubule. However, though our understanding of the mechanism is not yet clear, the fact is quite clear that dehydration plays an important rôle in diabetic ketosis. This must be borne in mind particularly when surgery is contemplated, and along with the administration of glucose and insulin required to prepare a diabetic patient for surgery, dehydration must be overcome by the adequate administration of water and salt. We (65, 72) have demonstrated the importance of adequate rehydration in a group of 474 surgical diabetic patients. The pre-operative and postoperative regime is based entirely on the urine findings according to the guide shown in Table I.

The rôle played by water and salt loss in massive burns has been generally recognized. The coincidental loss of proteins is often overlooked. The forms of treatment that aim at skin tanning serve their purpose by the prevention of the continued loss of fluid from otherwise open, weeping ulcers. Fantus (21) points out the importance of water and salt replacement, as well as transfusions to replace protein loss.

Long continued massive purulent drainage may prove a factor in the critical loss of protein. The so-called nutritional edemas seen in such cases may in great part be due as much to the protein loss as to the inadequate intake of protein in the diet. Here, too, transfusion is indicated, together with a high protein diet.

TABLE I.—PRE-OPERATIVE AND POSTOPERATIVE GUIDE FOR THE SURGICAL DIABETIC PATIENT BASED ON URINALYSIS

Urinalysis	No Sugar	Sugar	Sugar and Acetone
Carbohydrate	50 gm.	50 gm.	50 gm.
Fluid (.85 per cent sodium chloride)	1,000 c.cm.	1,000 c.cm.	1,000 c.cm.
Insulin units	10–15	20–30	30–40

WATER AS A DEHYDRATING AGENT.

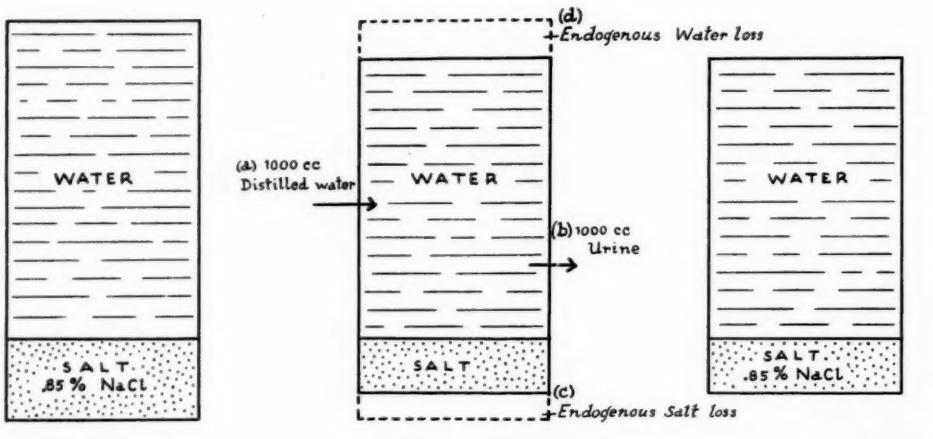

Fig. 5. Illustrating the normal water-salt ratio at the left. The mechanism of water loss shows (a) the ingestion of 1,000 c.cm. of distilled water, (b) its excretion as urine, (c) the endogenous salt washed out in urine, and (d) the equivalent water loss to restore the normal water-salt ratio. At right, the loss of body water as the final result.

PRINCIPLES INVOLVED IN REPLACEMENT THERAPY

The clinical derangements in water and salt metabolism have been mentioned. When do the intrinsic compensatory mechanisms fail to restore equilibrium, and what are the therapeutic methods at our disposal to aid in such restoration?

Before discussing the abnormals it would be clearer to summarize briefly the normal way in which the body handles water. Figure 5 represents a body in salt-water equilibrium. In this state a normal human kidney puts out from 60 to 70 c.cm. of urine a minute. If a normal subject were to ingest 1,000 c.cm. of distilled water, or tap water, the urine flow would rise promptly to from 300 to 500 c.cm. an hour, and within four hours the excretion would include 1,000 c.cm. over and above the normal excretion for that time. Theoretically it would appear that the subject should again be in his original state of water-salt balance. Actually he is not. He drank distilled water and excreted urine. No matter how dilute that urine may have been the diuresis carried with it, "washed out," a certain amount of sodium chloride. In order to restore his original salt-water ratio either the salt must be replaced or the body loses an amount of water the equivalent of the salt loss. It will thus dehydrate itself in order to keep its water-salt ratio constant. Peters (58) points out that the ultimate result of such water diuresis is the sweeping out of endogenous salt and interstitial water. The subject loses weight at the expense of extracellular fluid. We are thus faced with the apparent paradox that the more water one drinks the more dehydrated he becomes. However, when this is carried to its ultimate absurdity it is found to be all too true. The most dramatic example of the effect of ingestion of large volumes of water is seen in excessive sweating in laborers in hot environments. They may ingest from 8 to 10 liters of water a day; it is excreted as sweat which carries salt with it; as a result, a certain amount of endogenous water is lost with each liter of water ingested. These subjects have been known to suffer from peripheral circulatory collapse associated with true dehydration shock.

Another result of the massive administration of distilled or tap water is the production of water intoxication. This occurs when, for some reason at present unknown, water is not excreted by sweat or kidney. It is postulated that this may be due to a hypersecretion of posterior pituitrin,

which causes a marked reabsorption of water by the tubules and thus prevents the excretion of water. Helwig (37, 38) reports 2 cases of twitchings, hyper-reflexia, convulsions, and unconsciousness following the administration of large doses of tap water by proctoclysis. The first case showed the typical post-mortem findings of water intoxication. The second, recognized in time, was treated vigorously by intravenous administration of hypertonic saline solution with recovery.

It can be shown that the administration of concentrated saline solution induces dehydration by the elimination of the endogenous water required to dilute it for kidney excretion. Thus both distilled water and concentrated saline solution may be considered dehydrating agents.

Isotonic saline solution, even when given in large quantities, induces a less prompt and less forceful diuretic response. A certain amount of the salt and water are retained and the body weight rises. If dehydration has existed before its administration, it will restore the depleted stores; if it is not needed it will ultimately be excreted without taking with it either endogenous salt or water. Figure 6 shows the comparative diuretic response to water and to saline solution.

From the foregoing it becomes clear that the body cannot retain water without salt, and when dehydration from any of the clinical diseases mentioned above exists, water replacement must be built on a structural scaffolding of salt. The question often is asked whether 5 per cent glucose solution, which too is isotonic with blood, can be used in place of salt. The answer is obviously "No." Glucose is disposed of by being burned to carbon dioxide and water, polymerized to glycogen, or reduced to fat, and distilled water is left behind; and distilled water, as pointed out above, is a dehydrating agent.

It would appear therefore that in the presence of dehydration without alterations in the acid-base balance, one need only administer physiological saline or its equivalent, and since in most instances starvation ketosis is also present, glucose should be added to combat it.

In the case of dehydration associated with acidosis and alkalosis, it would appear imperative that a neutralizing salt be administered; for alkalosis an acidifying salt, such as ammonium chloride, or calcium chloride; and for acidosis an alkalinizing salt, such as sodium bicarbonate or sodium lactate. This is unnecessary in most instances. The same saline solution and glucose used for neutral dehydration is adequate in most cases of acid-base derangement. Such a uniformity of therapeutic method appears at first sight an extremely unscientific one, a sort of "shot gun," empiric prescription for all contingencies. Shot gun it is; empiric it is not. It is based on an intimate knowledge of the functional elasticity of the kidney, which shares with other organs what Cannon has described as, "the wisdom of the human body."

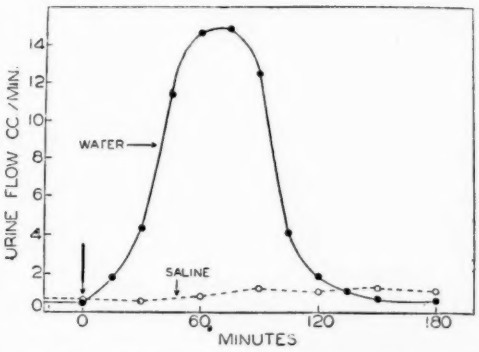

Fig. 6. The response of the kidneys in man to 1,000 c.cm. of water or, alternately, 1,000 c.cm. of 1 per cent sodium chloride solution ingested at zero minutes. In this experiment 92 per cent of the water was recovered within 180 minutes. (Experiment by J.A.S.) From Smith (41).

It has long been known that the kidney can select for retention or excretion those substances needed or not needed by the body, provided, (and it is an extremely important provision) there is a sufficient amount of water available for adequate urinary volume. Given an adequate supply of both basic and acidic ions to work with, and a sufficient amount of water in which to excrete them, the normal kidney demonstrates a most delicately geared mechanism. In alkalosis it will excrete fixed base in large quantities, with bicarbonate; will retain chlorides and ammonium; and most of the nitrogen will be excreted as urea. In acidosis the finished urine contains practically no fixed base; ammonium is excreted to spare base; and little urea and large quantities of chlorides are excreted.

With such a mechanism to depend upon, extrinsic replacement need only supply:

1. Water for pre-existing dehydration, and an excess of water over salt, i.e., a hypotonic solution to ensure adequate diuresis.

2. Salt to replace salt losses and to permit retention of water; no metabolizable substances can replace salt in this capacity.

3. Glucose to combat the ketosis which is so frequently present.

4. Blood by transfusion when protein loss has been marked, or for hemorrhage.

DETAILS IN INDICATIONS, MATERIALS, METHODS, AND MECHANICS IN REPLACEMENT THERAPY

Indications. When does replacement therapy become an important element in treatment? What evidence is there that fluid and salt, or protein, loss has become a significant factor in the patient's morbidity, or a critical factor in an impending mortality?

Clinically, all physicians of experience can recognize the dry tongue, the lusterless teeth, the shrunken lips, the sunken eyeballs, the loss of skin elasticity, and the cry of thirst as evidence of marked dehydration. These are, however, advanced signs. Effective therapy must be instituted earlier. At present we have no method available for the measurement of the total body water. On the assumption that changes of body water are reflected more or less equally in all three reservoirs, i.e., the blood, the extracellular fluid, and the intracellular fluid, examination of the blood may be used as a measuring rod for the other two.

The total blood volume can be measured with a fair degree of accuracy by the vital-red method or the carbon-monoxide method. Each is, however, a long procedure which limits its value in practical application.

The red blood count and hemoglobin can be determined quickly and, except in pre-existing anemias or polycythemias, gives a fair index of the state of dehydration as shown by a rise in the total cell count and hemoglobin. In fluid loss due to hemorrhage, there is a fall.

The hematocrit determination measures the relative volumes of plasma and cells in the whole blood. Normally the cells make up something less than 50 per cent of the total blood. Variations in the cell count would give hematocrit readings that could be falsely interpreted. In acidosis the cells imbibe water at the expense of the plasma. Alkalosis has the opposite effect. In acidosis the hematocrit reading would be high, in alkalosis, low with no actual total change in the body water.

The normal plasma protein concentration values range between a low of 6.3 gm. per cent in women and a high of 8.5 in men, the average being about 7 gm. per cent. Increases in the plasma protein concentration occur with loss of water from the plasma. In Gamble's experiments (25) with fistulas of the pancreatic duct the plasma protein concentration remained practically unchanged for about ten days during which time there was a reduction of the body weight of over 20 per cent mainly due to water. Evidently this is not an early sign of dehydration. Further, the technique and time required for this determination make it impractical for clinical use.

The normal plasma chloride content is 350 mgm. per cent. With depletions following vomiting there is a fall in the chlorides. Such falls may be considered critical when they reach below 250 mgm. per cent. The chloride content of cells is half that of plasma. In hemorrhage, chlorides may be high for that reason.

There is a wide normal range in the potassium concentration. In cells the concentration ranges between 350 and 465 mgm. per cent; in plasma, from 18 to 21 mgm. per cent. Note that the cell value is almost 20 times the plasma value. The interpretation of figures in dehydration states would be greatly affected by the increase in the red cells per unit volume without a real increase in potassium. Scudder (67, 68, 69) has collected an excellent group of figures on potassium values in intestinal obstruction.

In acidosis and alkalosis due to bicarbonate loss or excess, the measurement of the carbon-dioxide-combining power is of distinct value. The normal figure is 60 c.cm. per cent. The most marked falls occur in diabetic acidosis in which values of 20 c.cm. per cent or less have been reported.

A recent modification of the hanging drop method of determining the blood specific gravity makes this procedure available in the ward. Its value in indicating the plasma water loss is still to be proved. The normal variations in serum protein mentioned above may be greater than the organic changes involved in the subject under investigation. Since the specific gravity depends almost entirely upon the protein values, their wide range introduces an appreciable error in its use.

A simple test for urinary chloride excretion is suggested by Fantus (20). The technique is simple and roughly quantitative. The procedure is as follows:

Ten drops of urine are placed in a test tube, and 1 drop of a 1 to 5 potassium chromate solution is added which causes the solution to take on a definitely yellow color. Then drop by drop (with the same dropper or one of equal caliber) a 2.9 per cent solution of silver nitrate is added until a distinctly red-brown color appears. The number of drops required expresses in grams per liter the chloride content of the urine.

This test on each twenty-four-hour urine specimen will give an early indication of salt retention

FLUID INTAKE AND OUTPUT CHART

Name..... Ward..... Date Adm.....

Date														
INTAKE: Mouth														
INTAKE: Rectum retained														
INTAKE: Transfusion														
INTAKE: Infusion														
INTAKE: Clysis														
INTAKE: Total (Blue)														
OUTPUT: Urine														
OUTPUT: Vomitus														
OUTPUT: Fistula, diarrhea														
OUTPUT: Total (Red)														
Urine Sp. Grav.														
Grams Glucose retained														
Grams Salt retained														
	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out	In	Out
6,000 c.cm.														
5,000 c.cm.														
4,000 c.cm.														
3,000 c.cm.														
2,000 c.cm.														
1,000 c.cm.														
Remarks														
Chill, pyrexia														
Thirst														
Edema														

when compared to salt administration. This may be included on the intake and output sheet (Chart 1).

It has been pointed out that the urine closely reflects quantitative changes in the water-salt ratio as well as alterations in the acid-base balance. The urine volume falls markedly in dehydration. With this in mind, simple urine volume determinations with specific gravity offer a delicate measure of the importance of dehydration. Except in cases of acute nephritis, or late arteriosclerosis in the aged, a urine flow between 600 and 1,000 c.cm. with a specific gravity of 1.030 may be accepted as an indication that dehydration is not a major contributing factor to the patient's morbidity. Urine flows below 600 c.cm. in the absence of kidney damage must be interpreted as functional kidney failure due to an insufficient amount of water made available to the kidney for adequate urinary volume. Under such circumstances water replacement should be considered imperative, both to replace fluid loss and to induce diuresis to promote adequate excretion. This is by far the simplest method available for the determination of dehydration. It has been in use on our Third (New York University) Surgical Service at Bellevue Hospital, and has been found adequate. Blood studies are useful particularly in protein losses and give a more detailed picture of the altered chemical anatomy. They are complex, require some time for completion, and are not indispensable in the actual treatment of the patient.

Materials.

Blood administered by transfusion. For hemorrhage this is specific and curative. For shock with peripheral circulatory failure, transfusion is one of the best forms of therapy. However, it is not curative. The paralyzed capillaries in shock are no respecter of bloods, and they will throw out the donor's plasma, as they have the host's, with equal impartiality. When loss of protein accompanies dehydration, as in massive purulent wounds, in massive burns, or following prolonged diuresis with washing out of native proteins, blood transfusion is the ideal treatment.

Methods to make blood for transfusions more readily available have led to its preservation at low temperatures. Blood so gathered has been used three weeks after its withdrawal with no untoward effect. Lundy (47) stated that, for purposes of economy, blood from a donor's relative which is the improper type for the patient, may be taken and stored for future use. A com-

patible blood may be used from that already stored, or a suitable donor procured for the patient without his having to pay for it, the relative's blood being taken in exchange. Yudin (78) reports the use of blood obtained from cadavers after sudden death. Blood drawn within six or eight hours after death, citrated, and kept in a refrigerator at +3° C was used from two to three weeks later with no ill effects.

Lyophile serum. Methods for the preservation of normal blood serum in desiccated form have been developed (19, 23, 54). In this dry form all the solid elements are preserved; the proteins appear to be unaltered and their antibody titers remain unchanged. Bond and Wright (9) redissolved it in water and used it in experimental shock and hemorrhage. Their results were inconclusive as reactions occurred, and the question of compatible blood types was not worked out. The clinical value of this serum must yet be proved.

Acacia solution. This is usually put up in the form of a 6 per cent solution in normal saline solution. Its advantage over crystalloidal solutions lies in its being a large protein molecule, less likely to diffuse out of the capillary bed into the surrounding tissues. Thus in shock the experimental evidence reveals a more sustained rise in the blood pressure following the intravenous administration of acacia than after the administration of normal saline or Ringer's solution. Acacia, at the present time, is adequately sterilized, and there is not the old fear of its retaining tetanus spores. Studdiford (73) reports severe and fatal reactions following the intravenous use of gum acacia due to its toxic effect upon the liver. Maytum (49) cautions against the development of sensitivity to acacia manifested at its second use in the same patient when a period of from two to three weeks has intervened. The volume injected varies between 300 and 500 c.cm. It is a viscous solution and is best given slowly.

Glucose given as a 5 per cent solution has its ideal indication in the presence of ketosis. It may also be used intravenously in that strength which is isotonic with plasma in order to introduce the effect of distilled water to evoke a diuresis. Distilled water should never be given intravenously. The speed at which glucose is administered should not exceed the rate at which it can be abstracted from the blood stream. Woodyatt, Sansum, and Wilder (77) calculated this rate in dogs as being 0.8 gm. per kilo per hour. If this can be translated quantitatively to the human being, a man weighing 70 kgm. should be able to absorb 56 gm. of glucose in an hour. In other words, in 5 per cent strength (50 gm. to the liter) a subject weighing 70 kgm. should be able to receive 1,000 c.cm. of solution intravenously in one hour without spilling any into the urine. Clinically this is not found to be true. Often at rates of from 300 to 400 c.cm. an hour a glycosuria appears.

Saline solution. Sodium chloride in .85 or .4 per cent solution may be used in cases of neutral demineralization or in acidosis or alkalosis provided there is adequate kidney function. Its use in intestinal obstruction has been repeatedly emphasized (14, 15, 35, 36, 50, 56). In circulatory failure of either central or peripheral origin, in the advanced age group, and in the presence of obvious kidney damage the quantity of sodium chloride given must be carefully followed if complications are to be avoided. The .4 per cent solution or even the .2 per cent solution is more advisable in the latter group.

Ringer's solution is to be used for the same indications mentioned for physiological saline. It has the added advantage of supplying the other cations, calcium, and potassium, in the concentrations found in normal plasma.

Hartman's solution is a slightly diluted Ringer's solution plus sodium lactate. The dilution makes it hypotonic to plasma and so evokes a swifter diuresis. The sodium lactate is an alkalinizing salt and one that combats ketosis. The lactate is burned to carbon dioxide and water, as any carbohydrate which leaves basic sodium in excess. In severe acidosis or in the aged the addition of the alkalinizing salt offers an immediate base for neutralization.

Water, either distilled or tap water, has a real and important place in this group of derangements. Its most important function is the supply of the medium in which the kidney can perform its function as the controlling mechanism in the maintenance of the acid-base balance. For this purpose it is irreplaceable. It may also be used to release edema due to salt retention. However, it should not be used to replace lost tissue or plasma fluids, since the body normally cannot retain water without salt. Distilled water, as such, should not be given intravenously since it may lake the red cells in contact with it. As discussed under glucose, it may be given with 5 per cent glucose. The glucose is metabolized and leaves distilled water behind.

Concentrated glucose or sucrose (50 per cent solution). The use of concentrated solutions for purposes of dehydration in acute cerebral trauma had its origin in 1919. Weed and McKibbon (76)

demonstrated reductions in the intracranial pressure following the intravenous and ingested introduction of hypertonic saline solution. Fay (22) has summed up the advantages of 50 per cent glucose or sucrose over saline solution. States of water retention manifested in areas other than the cranial cavity are equally amenable to dehydration therapy. The physiological mechanism consists of the withdrawal of extracellular fluid into the vascular bed by the increased osmotic tension exerted by the concentrated solution. This is carried to the kidney and there excreted. Sucrose is the preferable solution since it is a non-metabolizable sugar when injected intravenously and is quantitatively excreted by the kidney. Fifty cubic centimeters of a 50 per cent solution may be used to release pulmonary or diffuse edema; this amount may be repeated in three or four hours, if necessary.

Saline solution 5 to 10 per cent. Concentrated saline solution finds its greatest usefulness in water intoxication, i.e., the retention of water without salt, probably due to a derangement in the tubular reabsorption mechanism controlled by the anterior pituitary hormone.

Routes of Administration.

Mouth. It is well to bear in mind that the intestinal tract is still the best equipped organ for the absorption of ingested material. In cases of massive burns, in shock not associated with gastro-intestinal derangement, or in diabetic ketosis not associated with vomiting, fluids can be administered by mouth. A simple method that assures fluid and salt intake is to insert a duodenal tube connected to a reservoir which feeds a constant drip into the stomach. The advantage of the oral method is obvious since proteins and medications may be added to the fluid. There is the added advantage of normal absorption and the unlikelihood of complications due to the administration of excess fluid.

Rectum. Water, salt, and glucose are absorbed by this organ. In dehydration, absorption by rectum is markedly increased, and considerable quantities of fluid can be administered by rectal taps. As much as 300 c.cm. may be given every two hours in such states with complete absorption before the next instillation. Glucose should be given in 1 per cent solution. Stronger solutions (57) soon irritate the mucosa and produce an inflammation which bars further absorption. The glucose may be dissolved in normal saline solution.

Subcutaneous hypodermoclysis. Within the past five years this method of fluid replacement has been almost entirely discarded by the Third (New York University) Division of Bellevue Hospital. It is a painful method; the quantity of fluid that may be given is limited; its absorption in states of circulatory collapse is uncertain; and we have had several massive sloughs following the use of glucose in saline solution. In infants this method is still in use, the amounts being smaller and the intravenous route often offering technical difficulties not encountered in the adult.

Intravenous infusion. This is being used exclusively in our wards at the present time. It has none of the disadvantages of the hypodermoclysis, and the older complications following its use have been almost entirely eliminated. The proper preparation of the infusion fluids, the adequate care of the dispensers, needles, and rubber tubing have almost completely eliminated the frequent chill and pyrexia following its use.

Mechanics. There are, at present, many types of dispenser in use for infusion. The older types consist of a compact metal box containing the entire apparatus which can be sterilized as a single unit. The fluid to be used is poured into the graduated cylinder which is part of this unit. The newer methods utilize the fluid container as the dispensing vial thus eliminating one source of contamination and reducing the sterilizing unit to the tubing and needles with no breakable glassware requiring sterilization. The older and some of the newer dispensers are shown in Figure 7.

The source of the "pyrogenic" substance in infusion fluids has been demonstrated by CoTui and his co-workers (16, 17) as being of a particulate nature of a larger order of magnitude than 50 millimicrons. This can be effectively removed from infusion fluid by passing the final fluid mixture through compressed asbestos filters of the Seitz serum No. 3 type. Our present process of preparing fluids for intravenous use is that outlined by the above author. It consists of distillation, the addition of chemicals, absorption filtration, and finally, sterilization. The container is used as the dispenser. With this method of preparation we have practically eliminated so-called infusion reactions.

For smaller hospitals the purchase of prepared infusion materials from supply houses will be found more convenient and less expensive than the establishment of a sterilizing plant.

Some details of administration may be worth repeating. We make little attempt to keep the flask warm after it has once been raised to the proper temperature and connected. A simple method of taking the chill out of the fluid consists in running the tubing along the wrist and forearm to the cubital vein and bandaging it next to the skin. The body temperature, plus the original

warmth of the solution, is usually sufficient. The effect of cooling by infusion fluid must be minimal since it meets so much larger a blood volume.

The speed of infusion rarely exceeds 300 c.cm. an hour. When this amount is added to a circulation of from 5,000 to 6,000 c.cm. a minute, the cooling effect can be seen to be minimal. Rates of 500 c.cm. an hour are not unusual and we have seen no untoward effects from them. A Murphy drip delivering from 70 to 80 drops a minute is adequate. This can be checked by one's own pulse rate.

The amount of infusion is an important item. The late Stewart, when asked how large an abdominal incision should be made answered "Large enough." The same may be said of infusion fluids; enough should be given. Yet we have no direct measurement of body fluid; we have no definite knowledge of how much fluid and mineral matter has been lost before admission. We have only the general appearance of the patient and the laboratory data mentioned above, which is not always too exact or too reliable. Coller and Maddock (14) have made a lasting contribution of sound, practical significance in the determination of the quantitative needs of a dehydrated patient. The authors have shown that 3,500 c.cm. of fluid are needed daily, 2,000 for water of vaporization and 1,500 c.cm. for urine. This is a generous estimate and may be reduced. If there is loss by vomiting or by a fistula of the intestine the amount lost should be added to the 3,500 c.cm. For patients who come in marked dehydration they advise the maintenance requirement of 3,500 c.cm. plus water, the equivalent of 6 per cent of their body weight. Thus a patient weighing 60 kgm. would require 3,500 plus 3,600, a total of 7,100 c.cm. (Table II).

One point should be stressed in undertaking the replacement of this fluid loss. That is that one should not attempt to achieve this replacement within a matter of hours. Like the aged diabetic in coma or impending coma who must be brought out of it slowly if one is to avoid a catastrophe, these patients in dehydration, particularly the older age group and the group with circulatory failure, whether the condition be of peripheral or central origin, should be rehydrated judiciously. There is no absolute necessity to replace the entire 7,000 c.cm. at one fell swoop. It is much safer to re-establish good urine flow by the use of hypotonic solution, i.e., glucose in .4 per cent saline solution, even though that would mean a somewhat smaller water retention for the first twenty-four hours, and then continue parenteral fluid for a longer period of time in smaller amounts.

COMPLICATIONS

Chill and pyrexia, which have been mentioned.

Salt edema. This is to be expected in the aged with arteriosclerotic kidneys whose last stand under usual circumstances is their ability to put out a large volume of urine of low specific gravity. Faced with the necessity of putting out some extra 30 or 40 gm. of salt a day, they fail; the salt is retained; and just as surely as the body cannot retain water without salt, just so surely can it retain water with salt. Water is retained until edema becomes plainly manifest.

Edema from hypoproteinemia. When the original disease has been a prolonged and debilitating one, protein has been lost during its course. Massive infusions, now administered, wash out proteins until the diminution becomes critical. Normally, fluid is retained in the vascular system by the osmotic tension exerted by the plasma proteins against the intravascular hydrostatic pressure. With the fall in plasma proteins and no change in hydrostatic pressure, fluid is forced out into the tissues and edema develops rapidly. Kerkhof (45, 46) has demonstrated the necessity of both salt excess and hypoproteinemia in the production of edema.

Another source of edema arises in the increase of capillary permeability due to prolonged anoxia which is a not infrequent accompaniment of the shock syndrome.

The location of the edema is of extreme importance. Dependent edema in the extremities is well borne, and should be taken as a distinct warning signal. When edema distributes itself in the lungs, pulmonary edema becomes a critical factor in mortality. Moon's (51, 52) work on the production of pulmonary edema by the introduction of agents that injure capillary endothelium suggests strongly the possibility of what may be termed "local" shock in isolated capillary beds. In the lungs this may be a fatal complication.

Methods of Releasing Edema. Once established, the edema can be released if the underlying cause for its production is understood. The methods would include:

1. The intravenous administration of 5 per cent glucose in distilled water. From the earlier discussion of water as a dehydrating agent, we may expect that distilled water will wash out salt, and so release the water held by it. We have seen a massive edema extending to the chest wall completely released in forty-eight hours by the administration of 6,000 c.cm. of 5 per cent glucose in distilled water over that period.

2. The administration of concentrated glucose or sucrose solutions. Fifty cubic centimeters of

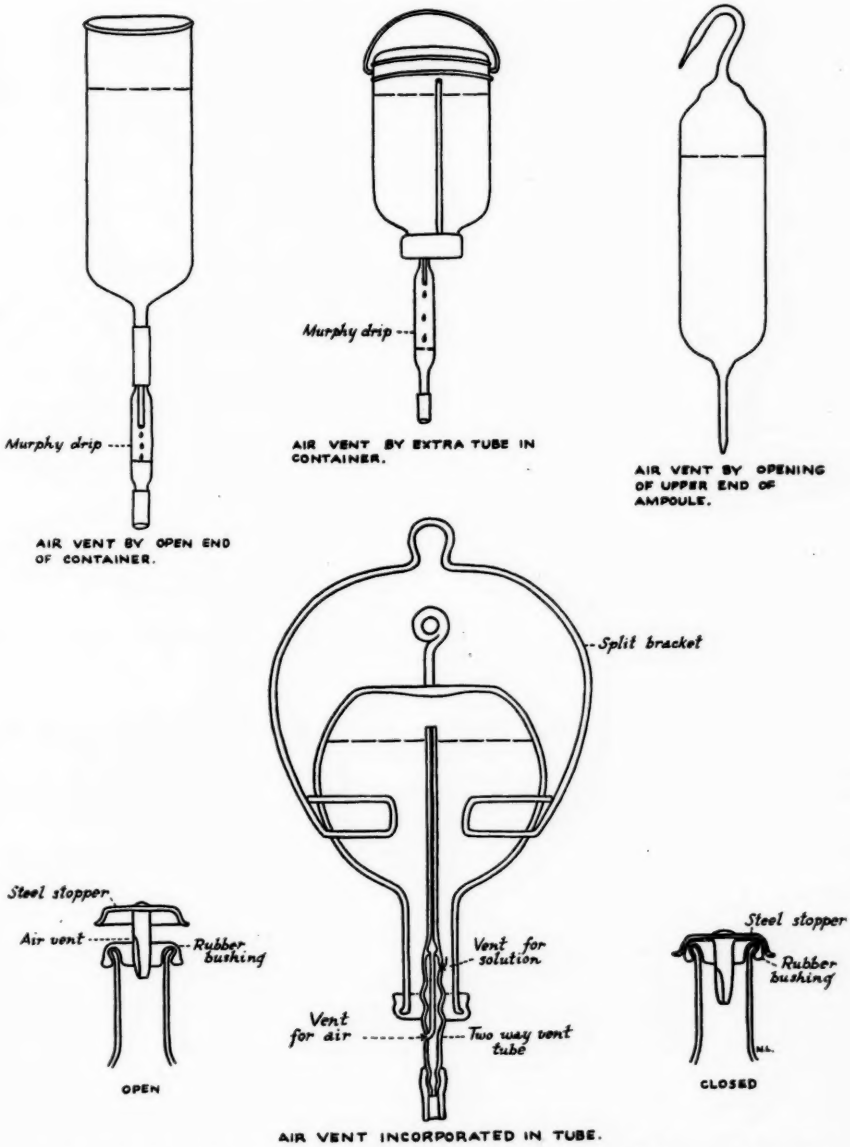

Fig. 7. Illustrating various containers for infusion apparatus. Upper left figure must have fluid poured into it from a sterilizing flask. In the other three the sterilizing flask is also the dispensing vial. All vials are calibrated.

TABLE II.—SOLUTIONS SUITABLE FOR PARENTERAL USE

Solution	Indications	Amount in 24 hours for 60 kilo man.
1. Sodium chloride, .85 per cent	Dehydration, acidosis, alkalosis, shock	3,500 c.cm. plus loss by vomiting or fistula
2. Sodium chloride, .4 per cent	As above and for oliguria	As above
3. Ringer's	As for .85 per cent saline	As above
4. Hartman's	As above and in severe acidosis and in the aged	As above
5. 5 per cent glucose in distilled water	Oliguria, salt edema, ketosis	2,000 to 3,000 c.cm.
6. 5 per cent glucose in .85 per cent saline	Dehydration, acidosis, alkalosis, ketosis, shock	As for .85 per cent saline
7. 5 per cent glucose in .4 per cent saline	Dehydration, acidosis, alkalosis, oliguria	As for .85 per cent saline
8. Sodium chloride, 5–10 per cent	Water intoxication	1,000–2,000 c.cm.
9. 50 per cent glucose or sucrose	In water retention, salt edema, pulmonary edema, increased intracranial tension	50–100 c.cm. Repeat in 4 hours.
10. Blood transfusion	Hemorrhage, shock, edema from protein loss	500–750 c.cm.
11. Acacia 6 per cent in saline	As for blood transfusion	300–400 c.cm.

Note: Of the crystalline solutions, 6 and 7 are found the most useful. The hypotonicity of 7 carries the advantage of a swift diuresis. By hypotonicity is meant the ultimate relationships to body water. As administered, all the above are either isotonic or hypertonic. All the above may be given intravenously.
1 - 7 inclusive may be given subcutaneously.

50 per cent glucose or sucrose solution may be injected intravenously. These agents act as dehydrating agents, as when they are used for reducing increased intracranial tension or pulmonary edema. The withdrawal of fluid into the vascular bed to be excreted by the kidneys is due to the hypertonicity of the injected fluid. Diuresis is prompt but of short duration and requires repetition of the procedure. Sucrose is more effective than glucose and its effect lasts longer.

3. Blood transfusion. This is the ideal method for the replacement of proteins as well as for overcoming anoxia and its consequent capillary functional damage.

4. The administration of acacia. Experimentally Kerkhof has proved the value of acacia in increasing the colloid osmotic tension sufficiently to withdraw fluid from the tissues for urinary excretion. He has demonstrated that edema does not occur in dogs following plasmapheresis if acacia is injected in strengths ranging from 6 to 30 per cent.

CONCLUSIONS

The recognition of states of dehydration and derangements in the acid-base balance opened a new field of therapy. Parenteral fluid and salt replacement added to the specific medical or surgical procedure has reduced morbidity and in some instances shown dramatic reduction in the mortality. It is a valuable addition to our therapeutic armamentarium. Like other methods it must be used intelligently.

The administration of intravenous fluid can be overdone. Too many liters of fluid are often poured into defenseless veins to do irreparable damage to defenseless patients. The statement is often heard, "Well give him another infusion, it can do no harm." The indication for therapy is not that it will do no harm; we have a right to demand that it do good.

In the aged, in patients with circulatory failure, and in patients with known kidney damage, parenteral fluids should be given with the greatest care.

In the normal adult, 3,500 c.cm. plus the amount known to be lost by the gastro-intestinal or other routes may be administered. This should be administered as a 5 per cent glucose solution with saline solution in hypotonic strength, (.4 per cent) to evoke a good diuresis.

The duration of the administration of parenteral fluid should be determined by the urine volume output and the specific gravity. When the urine flow is between 600 and 1,000 c.cm. a day with a specific gravity between 1.020 and 1.030, dehydration may be considered an unimportant contributing factor to the patient's morbidity.

A simple chart of fluid intake and output as illustrated will greatly facilitate the care of the dehydrated patient.

COMMENT

The appearance of an article on water and salt metabolism in a so-called "clinical" journal requires an apology or an explanation, or both. It will find justification before a group of clinical workers only if it succeeds in achieving a simplification in diagnosis or therapy of hitherto existing complexities in medicine and surgery.

Twenty-five years ago such an article could not have appeared because at that time practical methods for the analysis of blood had not yet been introduced to the medical profession. These methods were evolved in the chemical and physiological laboratories and have remained there. However, their interpretation has filtered out of the laboratories to the bedside where it belongs. Clinicians, as individuals, have tried to acquaint themselves with these new instruments placed at their disposal by the preclinical laboratories. Their response has been so eager and, in the main, so co-operative that the preclinician has stopped looking down his spectacles at the clinician as a therapeutic empiricist. A wise old physician in discussing the problem said, "What the doctor needs is a laboratory; what the patient needs is a doctor." Neither is superior, each has his place and his function.

In recent years we find the clinician welcomed to the laboratory as a fertile source of first-hand information gleaned at the bedside. With him have come such problems in clinical medicine and surgery as can be solved by the combined efforts of the trained laboratory worker and the trained bedside or operating-room clinician. As a further development of this symbiosis there is emerging the newer clinician, the doctor trained in the chemistry or physiology laboratory who can apply that knowledge at the bedside or in the operating room.

Medical school curricula have changed to meet these new advances. There was a time when a student was taught the detailed symptoms of a disease which he then had to label. His excellence as a student was then measured by the number of such labels he could conjure up out of his memory. Today we stress the underlying physiological derangements responsible for the symptoms seen in the disease. The student thus becomes rich in principles rather than in facts. He learns to bring together under one common denominator various diseases that have no apparent clinical similarity, but which share a common fundamental dislocation. For example, he finds a clinical disease entity in mountain sickness, and a physiological identity in carbon-monoxide poisoning, congestive heart failure, or pernicious anemia in that each is an example of oxygen lack. He learns to consider such a group under the unified heading of anoxia.

Similarly he learns to group together a number of clinically unrelated diseases in each of which water derangement plays a significant or critical rôle. Clinically there is no apparent similarity between a patient suffering from a ruptured ectopic pregnancy and one with acute intestinal obstruction, or a patient in diabetic coma. Yet in each there has been a loss of body fluid, the replacement of which may prove the determining factor in recovery.

With such an understanding of disease, the complexity of unrelated details takes on a unified simplicity, and makes for a more reasonable understanding of symptomatology and for a more rational form of therapy.

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RECENT GLAUCOMA OPERATIONS, WITH SPECIAL REFERENCE TO METHODS AND INDICATIONS

Collective Review

SAMUEL J. MEYER, M.D., F.A.C.S., and THEODORE N. ZEKMAN, M.D., Chicago, Illinois

THE past year has disclosed some modifications of older procedures in an attempt to improve the ultimate end-results or length of duration of "cures," especially in the treatment of compensated glaucoma (glaucoma simplex.) It is not altogether clear as to why certain eyes retain a normal tension after surgical interference, and other eyes require multiple surgical procedures to control the tension. This is probably due to the fact that the present surgical treatment is symptomatic, as the underlying etiology is still a questionable factor.

Barkan (3) published accounts of a new operation in which he refers to his investigations of the cause of glaucoma and states that in over half of the cases of non-congestive primary glaucoma, obstruction of the outflow of aqueous from the anterior chamber into Schlemm's canal causes the condition. This obstruction is located in the sclerocorneal trabeculum. He states that these conclusions are confirmed by the incision of the trabeculum and the opening of Schlemm's canal, which restores the normal tension. This is the basis of his goniotomy operation, which consists of the opening of Schlemm's canal by means of a knife introduced at the temporal limbus and carried across the anterior chamber until its blade disappears behind the nasal limbus. He now uses a specially constructed contact glass and a head loupe, which enables him to follow the knife while it pierces the trabeculum and opens Schlemm's canal. His conclusions and summary are as follows:

"It is suggested that this operation, which restores the physiological function of Schlemm's canal, solves the surgical problem of most cases of chronic primary glaucoma. It is equally successful in certain cases of secondary glaucoma. The results are predictable and appear to be permanent. It involves a new principle in the surgery of glaucoma in that the angle of the anterior chamber and Schlemm's canal are under full view and magnified during the operation. The operation is without danger when the proper technique is used and has proven completely successful in the writer's hands when certain preoperative indications (binocular biomicroscopic diagnosis) have been fulfilled."

Brecher (5) reports upon one case in which he attempts to improve upon the conventional cyclodialysis operation. He states that the chief defect in a simple cyclodialysis is that the ciliary body becomes attached again to the overlying sclera shortly after it is separated surgically, and the tension-regulating communication between anterior chamber and suprachoroidal space disappears. He attempts to prevent this closure by inserting a 5 by 4 mm. piece of egg membrane into the suprachoroidal space after performing a typical cyclodialysis. The membrane is pushed in with a spatula until it reaches the anterior chamber and the posterior edge protrudes slightly from the scleral wound and is covered with the conjunctiva.

Grosz (11) reports the use of glaucosan iontophoresis according to Weve's method with the electrode of von Heuven in a series of 13 cases. The dose is one minute at one sitting, and as a rule 2 treatments are necessary. Usually good results were noted in secondary glaucoma, in aphakic eyes, and in inflammations of the uvea. In other cases of secondary glaucoma, and in primary glaucoma, there was no improvement noted. This method may also be used for diagnostic pupillary dilatation and lowering of the tension preparatory to operation, because this method works better and is less painful than the instillation method and may be repeated daily.

Berens (4) believes he has improved upon the Lagrange iridosclerectomy and the punch operation of Holth. His technique is to inject 1-percent novocaine solution with adrenalin over all recti muscles and the upper limbus region and 1 c.cm. of novocaine solution into the ciliary ganglion. A 15-mm. incision through the conjunctiva is made with a Steven scissors 10 mm. above the limbus and the conjunctiva dissected down to the limbus where the cornea is split further for a distance of 1.5 mm. A curved keratome is inserted 1.5 mm. above the cornea and a 4 mm. incision made into the anterior chamber. The iris is pre-

vented from prolapsing, if possible. If not, it is replaced. The scleral wound is enlarged at both ends with the same scissors for a distance of ½ mm. The corneoscleral lip is punched out with a punch, so that an irregular saw-like wound from 0.5 to 0.7 mm. into the cornea is produced. Total iridectomy is performed in congestive glaucoma and peripheral iridectomy in non-congestive glaucoma. The iris is replaced by means of irrigation of the anterior chamber with normal saline solution. The conjunctiva is closed with a running suture anchored at both ends. The anterior chamber is again irrigated. Metaphen unguentum (1:2500) and atropine are instilled. The eye is massaged 3 times daily following the first twenty-four hours. There were 73 operations on 68 eyes of 50 patients; normal or sub-normal tension resulted in 86.8 per cent of 38 primary glaucomas, in 73.1 per cent (26 eyes) in secondary glaucoma, and in 75 per cent (4 eyes) in acute glaucoma. The postoperative treatment necessitated 5 paracenteses, 2 enucleations, modified iridotasis and trephines, 2 posterior and 1 anterior sclerectomies. There was 1 expulsion of a small lens in microphthalmos, several ruptures of the conjunctival bleb, and frequent iritis. Berens recommends the operation in all forms of glaucoma, such as chronic, non-congestive, and secondary, and also in glaucoma after lens extraction.

On the theory that the lowering of tension following a cyclodialysis was due to a decrease in the production of aqueous secretion on account of an atrophy of the ciliary body, Vogt (22) attempts to produce the same process by diathermic destruction of the ciliary body. After dissecting the conjunctiva surrounding ½ to ⅝ of the circumference of the cornea, from 50 to 100 or more ½ to 1½ second diathermy punctures are made from 1½ to 3½ mm. from the limbus, with a needle 0.2 mm. in diameter and 1 mm. in length. The area is covered with conjunctiva. The operation may be done in two or more sittings. The current used may vary from 60 to 90 ma. The eye may become quite soft during the procedure. At the time the report was written, sufficient time had not elapsed to tell definitely if any harm to the lens may have occurred.

An improvement upon the Seton operation in glaucoma, first advocated by Zorab in 1912, was promulgated by Wolfe and Blaess (24). Their method consists of preparing conjunctival pockets in the inner and outer quadrants, extending down to the cornea. A 3 mm. incision is made into the anterior chamber with a keratome. A white silk thread is then inserted into the anterior chamber with aid of a blunt tear-sac needle, and so placed that the free ends extend from 4 to 5 mm. into each conjunctival pocket. The conjunctiva is closed with running sutures, which are removed five or six days later. If no fistula is produced, the suture may be manipulated to and fro through the conjunctiva, with a forceps.

Several years ago, Sallman advocated the use of a trephine opening in place of a scleral incision with a scalpel or keratome for a typical cyclodialysis. Petrow (19) advises that a similar effect can be obtained when a trephine is not available. He states that the incision with a scalpel should be made through the sclera obliquely toward the cornea instead of vertically. A second incision from 1 to 2 mm. nearer the limbus is made with a scalpel, a spatula being kept inserted in the wound to prevent trauma to the deeper tissues. This scleral piece is then excised; or the spatula may be removed, and the distal portion of the incised piece of sclera seized with a forceps and excised with a scissors. No complications are reported. As a rule, the results were favorable, the tension remaining normal. Eighteen cases were reported upon, of which 13 were compensated, and 5 absolute, glaucomas. Tension before operation was between 33 and 70 mm. Hg.; afterward between 10 and 30. The longest period of observation was two months.

In an attempt to decrease the difficulty of forcing a spatula into the anterior chamber during a cyclodialysis, Archangelsky (1) devised a spatula forceps similar in appearance to a deWecker scissors, curved to fit the curvature of the eyeball. This instrument is inserted into the anterior chamber with the blades closed, the same as a cyclodialysis spatula, the blades are separated, the instrument withdrawn with the blades partially separated. The advantages are presumed to be an easy entrance into the anterior chamber and absence of lateral eyeball movement during operation.

Postoperative glaucoma is a subject of prime importance to all ophthalmologists. Following a search of American literature as to its etiology, Fox (9) states that the consensus of opinion seems to be that it is due to a plugging up of the anterior chamber angle. He reports on 1,629 operations, of which 1,182 were lens extractions and 447 discissions. There were 14 cases (1.2 per cent) of glaucoma following lens extraction and 10 cases (2.2 per cent) after discission. The causes for the increased tension were as follows: a thickened secondary capsule in 6 cases, lens matter in the anterior chamber in 4 cases, anterior synechia in 4 cases, capsule remnants in the wound in 3 cases, and glaucoma before operation in 1 case. These

statistics agree with those of Knapp who reported increased tension in 1.2 per cent of 400 cases of intracapsular lens extraction, and about the same frequency after extracapsular extraction. The increased tension occurred from two days to twenty-two months after the operation, and in 10 cases within one month. Methods of treatment recommended are: iridectomy with hooks, basal iridectomy, incision of the incarcerated capsule remnants, trephination and cyclodialysis. The prevention of increased tension is facilitated by keeping the anterior chamber clear after operation. Fox states that the prognosis of postoperative glaucoma is not good.

Wheeler (23) advocates an iridectomy with cyclodialysis in refractory cases of glaucoma in which an iridectomy, trephine, or iris-inclusion operation has not sufficed to lower the tension to normal. The operation was originally recommended by Woottan in 1932 to prevent the formation of synechia and allow drainage through Schlemm's canal. Anesthesia is obtained by the instillation of 2 per cent cocaine, and the administration of novocaine subconjunctivally in the area of operation and by retrobulbar injection. Cyclodialysis is performed in the usual manner in either the upper or lower quadrant, with undermining of the conjunctiva to the limbus. An incision at the limbus is then made with a keratome, followed by a wide iridectomy which should extend to the ciliary body. Wheeler believes this method is indicated in cases in which miotics and conservative methods have failed. Czermak advocated a similar iridectomy thirty years ago.

In 1930 Kronfeld (14) reported a new provocative test to supplement the dark room and homatropine test to aid in the early diagnosis of glaucoma. This consists of complete emptying of the anterior chamber, which is followed in from one to two and one-half hours by a reactive hypertony. The anterior chamber puncture is usually harmless when a short needle is used and inserted flat while the eyeball is held with two fixation forceps by an assistant. In more than 400 cases, only 2 lenses were injured with resultant cataract formation. In a further series of 12 cases of early glaucoma, Kronfeld found that the resultant hypertony was 10.1 mm. Hg., or higher than in a similar number of control cases. The authors advise tension measurements every half hour for three hours, following the emptying of the chamber.

Strachow (21) concludes from his own experiences and an extensive perusal of the literature that the Elliot trephine operation leads to the best end-results as far as lowering the tension rapidly to normal and keeping it there is concerned. He maintains, however, that it is not entirely safe when a marked constriction of the visual field is present. One must also consider the danger of a late infection through the trephine opening. On the other hand, the cyclodialysis of Heine does not lower the tension as rapidly, but is not so dangerous a procedure when the visual field is quite constricted. He reserves the classical iridectomy of von Graefe only for cases of acute glaucoma, in which the anterior chamber is still deep enough to allow for a good surgical approach.

Heine (12) quotes the statistics from the Universitats-Augenklinik, Budapest, from 1904 to 1935, recently published by Grosz, which show that the original widely used iridectomy and the later Elliot trephine operations have been greatly supplanted by cyclodialysis during the past ten years. Heine postulates upon the origin and history of cyclodialysis and refers to an early work of Fuchs in 1905, in which the latter stated that the hypotony and choroidal detachment occurring after lens extraction is due to a fistula formation between the anterior chamber and the suprachoroidal space. This theory was later elaborated upon by Elschnig. Heine quotes the work of Vannas published from the German University Eye Clinic at Prague, in which postoperative gonioscopic examinations were made upon 37 cases of glaucoma in which cyclodialysis had been performed. It was found that in all cases in which the tension had been lowered to normal, a communication existed between the anterior chamber and the supraciliary space, in contrast to the cases in which the tension remained high, in which the sclera had again become attached to the ciliary body. In 3 cases in which a second cyclodialysis had been successful, it was found that the ciliary body had become reattached at the area of the first operation but remained free in the region of the second. Heine also quotes Elschnig's anatomical report of an eye upon which a cyclodialysis had been performed and in which he found an open communication between the supraciliary space and the anterior chamber. The cyclodialysis may be repeated several times if previous attempts are not successful in lowering the tension. Heine believes that cyclodialysis is contra-indicated in cases of glaucoma associated with iritis, as the further irritation of the ciliary body results in more adhesions at the chamber angle; for these cases he recommends repeated anterior chamber punctures. Heine does not recommend a combination of cyclodialysis and an Elliot trephination, nor a trephine operation for buphthalmos.

Auerbach (2) describes some very interesting experiences in attempting the prevention of an expulsive hemorrhage. An expulsive hemorrhage is always a disastrous affair and may occur in other than postoperative cases, such as perforating corneal ulcer. It most frequently follows postoperative interference, such as a Saemisch puncture for corneal ulcer. In the Helmholtz Eye Clinic in Moscow, it occurs once in from every 200 to 300 cataract extractions. It may occur at the time of operation, while the patient is still on the operating table, several hours later, or even several days later. If the operative wound is not ruptured, the eye becomes stony hard (malignant glaucoma.) The bleeding usually comes from the long ciliary arteries. As the sclera is a rather resistant structure, the blood usually forces out the entire intra-ocular contents except the choroid. Auerbach, in agreement with the recommendation of Von Grosz, Fromaget, Verhoff, and Filatow, believes that a preliminary Elliot trephine should be performed in eyes preparatory to lens extraction, when an expulsive hemorrhage has occurred in the previous eye. Three cases are reported with successful results.

Filatow (8) reports 8 cases in which he performed a prophylactic sclerotomy for the prevention of an expulsive hemorrhage, in 6 cases preparatory to a glaucoma operation, in 1 case before lens extraction from a glaucomatous eye, and in 1 case before cataract extraction in a patient who had lost the other eye following an expulsive hemorrhage. In the last case the choroid was injured and vitreous appeared. The lens extraction was performed under difficulty with a loop because of the softness of the eye. The postoperative recovery was uneventful. The prophylactic sclerotomy has two important factors. First, it allows for the drainage of blood from the subchoroidal hemorrhage. Second, it lowers the tension in glaucoma, so that the blood vessels are not unnecessarily constricted. In 1 case following sclerotomy the tension dropped from 46 to 26 mm.Hg. Sclerotomy is best done in the outer lower quadrant, midway between the equator and the ora serrata with a 2 mm. trephine, just before the major procedure. Protruding choroid usually replaces itself following the major procedure. The fact must also be considered that the hemorrhage may not be external, but into the vitreous body.

On the theory that the tension may be lowered by a reduction of the amount of blood allowed to flow into the blood vessels of the choroid, Sapir (20) recommends the tenotomy of the four vertical external muscles. By this procedure the anterior ciliary arteries are severed. In 4 cases the lowering of the tension was only transitory, but in many of the cases the tension remained normal for months. The results in 20 cases were reported. In several cases, exophthalmos and strabismus resulted. To avoid these complications the author ligated the four muscles with ligatures which were left in place at least ten days. In some cases he cauterized the muscle tendons with a thermocautery. The same lowering of tension occurred following all these modifications.

Working on the assumption that the simple cyclodialysis often fails to lower the tension, Kadlicky (13) performed iridencleisis according to Del Bario. Because of the short period of observation, only the intermediate results can be reported. Twenty-five operations were performed, 13 in simple, 10 in chronic incompensated, and 2 in acute incompensated glaucoma. The technique is simple, the risk no greater than in cyclodialysis. Once the lens was injured due to the injudicious use of a sharp hook, and once the iris was not pulled out far enough so the sphincter slipped back into the anterior chamber. The tension became normal in 23 cases and in 2 it remained high. In 2 cases the vision became worse because of hemorrhage into the vitreous. In 2 cases with excavated discs and marked contraction of the visual fields, function was lost in spite of the tension's remaining normal. Only 6 cases were observed over a long period of time, 2 for nine months, 3 for six months, and 1 for five months. The tension always remained normal. The decrease in function of the 2 cases enumerated was not the result of the operation, but was probably due to the general physical condition. In comparison to the other procedures, Elliot trephine, cyclodialysis, and iridectomy, the results appear to be better. In view of the fact that the operation is easy to perform and not very complicated, it is recommended by the author.

Marquez (18) recommends the use of an angular trapezoid pointed keratome for glaucoma operations. In sclerotomy *ab-externo*, this knife prevents injury to the iris even when the anterior chamber is very shallow.

De Saint-Martin (7) reports his technique, prognosis, and indications for the cyclodialysis operation. Forty cases of glaucoma simplex were operated upon, with a lowering of tension in 87.5 per cent, higher tension in 2 cases, improvement of vision in 20 per cent of the cases, and a decrease in vision in 45 per cent. Very similar results were noted in chronic inflammatory glaucoma. There were 23 cases operated upon with lowering of tension in 82.6 per cent, visual improvement in 42.8 per cent, and decrease in vision in 33 per

cent. Eight cases of acute glaucoma were operated upon with improvement in 5 cases, and decrease in vision in 3 cases. Three cases of absolute glaucoma were operated upon and the tension was lowered in 2. The complications consist of hemorrhage into the anterior chamber immediately after the operation, or recurrence in most cases; early hemorrhages were noted in 35 per cent, later hemorrhages in from 12 to 15 per cent. According to the author's views, the indications are somewhat limited; in agreement with Von Grosz, they are secondary glaucoma, subluxation of the lens, and aphakia.

Kubik (15) reports on 4 cases of glaucoma in which he removed a clear non-cataractous lens after other methods of treatment had been unsuccessful: 1. A case of glaucoma in a partial thrombosis of the central vein (one branch) in which iridectomy had failed to relieve the tension and the anterior chamber remained shallow. After an intracapsular lens extraction the tension remained normal. 2. A case of chronic glaucoma which became acute after pilocarpine instillation. Iridectomy did not cause improvement as there was a bilateral lens sclerosis (lens myopia). The author performed a bilateral lens extraction after a ten-day interval. In one eye, the tension became normal; in the other, only after a cyclodialysis. 3. A one-eyed patient who had had one eye removed on account of absolute glaucoma. The second eye presented acute glaucoma, and an iridectomy, Elliot trephine, and cyclodialysis had been unsuccessful. By means of intracapsular lens extraction, the tension continued to remain normal. Kubik believes that intracapsular lens extraction in many cases will result in a normal tension when other methods have failed.

Lauber (17) believes the foundation of the diagnosis of glaucoma depends upon the careful examination of the vision, visual field, and tension. These factors must be continually observed. Even in a successful course of this disease, control examinations should be made at intervals of two months. After the performance of an operation, a similar control observation is indicated. Medical treatment is indicated only so long as the vision and visual fields do not decrease. The tension should be taken only with a tonometer, and the visual fields measured with small test objects, preferably upon a campimeter of Elliot or Bjerrum. Any increase in the size of the scotoma indicates that the present method of treatment is ineffectual. When this occurs, one should not hesitate to repeat a surgical procedure or attempt another. The general physical condition must be considered, especially the blood pressure. A low diastolic blood pressure indicates a poorer outlook. Therefore, one should be very cautious in the attempt to lower the general blood pressure. In acute glaucoma, it is absolutely essential that the tension be lowered by one method or another. Surgical interference upon both eyes at the same time should be avoided, as the operative procedure upon one eye may sometimes produce a favorable effect upon the second eye and one may avoid the occurrence of a malignant glaucoma. Should one be suspicious of a malignant glaucoma, a posterior sclerotomy should be performed simultaneously with whatever other procedure is indicated. In chronic and simple glaucoma, Lauber believes the cyclodialysis to be the operation of choice. In malignant glaucoma, he advises posterior sclerotomy with removal of vitreous, if necessary, and lens extraction.

Denig (6) believes that by making an iris wick in a trephine, Lagrange, or cyclodialysis operation, there is less opportunity for the scleral opening to close and less chance for late infection to occur. He states that a scar containing uveal pigment is less apt to become infected than an ordinary scar. In these operations, he proceeds to make a spiral wick out of one angle of the cut iris by winding it around a wire and incarcerating same in the wound. This method is most applicable in conjunction with the Lagrange procedure. He states that the tension became normal in 94.7 per cent of the cases which he operated upon. This is a rather high percentage.

Lagrange (16) states that the value of iridectomy in acute glaucoma is unquestionable. It is disappointing in cases of chronic glaucoma. The solution of the problem here depends upon the durable fistulization of the eye and establishment of the principle of action of a subconjunctival and limbic sclerotomy, or fistulization of the eye as obtained by the subconjunctival resection at the scleral limbus of a fragment of the ocular shell. He describes the Lagrange iridectomy, with the scleral incision made with a Graefe cataract knife. The fistulizing treatment may thus be accomplished by three operative methods: namely, simple limbic sclerectomy, sclerotomy with peripheral iridian opening, and sclerecto-iridectomy. He claims that the fistulizing method succeeds in 85 per cent of the cases in chronic glaucoma, while iridectomy yields an average of from only 25 to 30 successful results in 100 cases. He concludes that it is necessary to operate without delay in cases of glaucoma in which medical treatment fails to reduce the ocular tension to normal limits, and operation is necessary, even if the medical treatment does reduce the tension to normal, should

alteration of the visual field progress in the slightest degree or visual acuity decline.

Concerning cyclodialysis, Gradle states that the operation of cyclodialysis is coming back into favor because of its comparative freedom from danger of disastrous visual results and because of the more permanent normalization of tension due to more careful observance of proper indications. As has been repeatedly emphasized, this operation is not a universal cure-all for all forms of glaucoma, but must be limited to those cases of compensated glaucoma that are just beyond control with miotics and to those cases of secondary glaucoma which occur subsequent to successful cataract extraction.

The universal choice of site of the incision through the sclera in cases of compensated glaucoma has been the lower outer quadrant. Of recent years, we have been more successful by operating in the upper outer quadrant. The reason for this is a purely mechanical one. After a properly performed cyclodialysis, there is bound to be more or less blood in the anterior chamber because of rupture of the ciliary vessels between the sclera and the ciliary body. This blood tends to settle to the bottom of the chamber, there form fibrinous adhesions in the angle, and completely block the suprachoroidal pathway that has just been made. However, if the upper chamber angle is freed with the cyclodialysis spatula and the patient is then kept upright in bed for twenty-four hours, the blood will all settle to the bottom of the chamber and thus have no opportunity to clog the new angle opening that has been made. It is needless to add that the operation should be followed by the use of a weak mydriatic in all instances.

In the cases of glaucoma secondary to cataract extraction, the site of operation should be chosen so as to free the pillars of the operative coloboma.

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ABSTRACTS OF CURRENT LITERATURE

SURGERY OF THE HEAD AND NECK

EAR

Lempert, J.: Endaural, Antauricular Surgical Approach to the Temporal Bone: Principles Involved in This New Approach; Summary Report of 1,780 Cases. *Arch. Otolaryngol.*, 1938, 27: 555.

Since the author's first report of 165 complete mastoidectomies performed endaurally ten years ago, he has aimed at the perfection of a surgical operation on the temporal bone through the endaural antauricular approach. His procedure consists of three distinct stages: (1) Operation on the superficial soft parts covering the temporal bone; (2) operation on the temporal bone proper; and (3) surgical treatment and guidance of the membranous and osseous wounds resulting from the first two stages.

The first stage consists of the creation of a mobile membranous and extracartilaginous window within the external auditory canal for endaural antauricular surgical approach to any desired part of the temporal bone.

In establishing an appropriate approach adequate for all types of operations, Lempert enumerates seven desirable factors: (1) A series of endaural incisions should be made in the soft parts anterior to the auricle and within the external auditory canal, which will lay the foundation of a membranous endaural window; (2) the endaural incisions must always remain extracartilaginous, in order to obviate the possible occurrence of perichondritis; (3) the window must afford adequate exposure of the temporal bone; (4) the window must be so designed that it involves the least possible sacrifice of tissues; (5) the window must be made mobile so that it can, together with the auricle, be freely moved and displaced in all desired directions over the temporal bone; (6) the window must be so constructed that it will remain wide open throughout the entire postoperative period of healing; and (7) the window must be so made that it will ultimately heal without deformity.

To enable the otologist to satisfy all the foregoing requirements, the author describes a new anatomical landmark which he designates as the antauricular suprameatal membranous triangle, a space filled with connective tissue and containing no important blood vessels or nerves. The surgical employment of this triangular membranous space makes possible the endaural antauricular approach to the mastoid portion of the temporal bone, the mastoid process and the tympanic portion of the temporal bone, and the mastoid process, the tympanic cavity, and the petrous portion of the temporal bone. The otological surgical procedures which the

Fig. 1. Membranous extracartilaginous endaural window for endaural antauricular approach to the mastoid process.

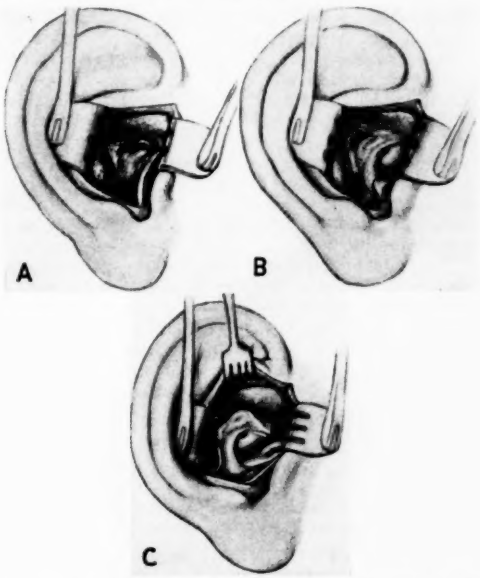

Fig. 2. A, complete endaural mastoidectomy (simple mastoidectomy); B, complete endaural mastoidotympanectomy (radical mastoidectomy); C, complete endaural mastoidotympano-apicectomy.

author has performed, in which he has employed the mobile membranous window, include the simple mastoidectomy, the modified radical mastoidectomy, complete exenteration of the contents of the lateral sinus for sinus thrombosis, drainage of abscesses in the middle and posterior fossæ, removal of obstructive exostoses of the bony walls of the external auditory canal, mastoidotympanolabyrinthectomy, complete apicectomy, and drainage of the cisterna pontis interpeduncularis.

In his discussion of the operation on the temporal bone proper, the author describes his method of opening the mastoid antrum through a definitely localized point in the superoposterior bony wall of the external auditory canal. His method, Lempert believes, is error proof. With this approach to the antrum, neither the middle cranial fossa nor the lateral sinus can ever accidentally be injured, no matter how anomalous an anatomical position these structures occupy. The prominence of the external semicircular canal and the transverse portion of the facial canal are never injured, because they are anterior and internal to the drill when it enters the antrum. The author strictly adheres to the rule of deliberate, systematic, and complete exposure of all the vital anatomical structures. He maintains that a focus of infection, no matter how remotely situated, cannot possibly escape detection and removal when such a technique is employed.

The author states that by his method the surgical management of the membranous and osseous wounds resulting from operations on the temporal bone assures constant unimpeded drainage of the osseous wound throughout the period of healing, constant visibility of the wound to permit inspection and guidance of the reparative process, a period of healing and convalescence resulting in the least possible social and economic inconvenience to the patient, and an ultimately healed osseous and membranous wound, the appearance of which approaches cosmetically, as nearly as possible, the pre-operative appearance.

The author has performed, by the endaural approach, 1,780 operations for suppurative disease involving all parts of the temporal bone and for every possible complication arising therefrom, in patients ranging from one year to eighty years of age, and with a mortality of 2.08 per cent.

NOAH D. FABRICANT, M.D.

NECK

Schmidt, L. H., and Hughes, H. B.: The Free and Total Cholesterol Content of Whole Blood and Plasma as Related to Experimental Variations in Thyroid Activity. *Endocrinology*, 1938, 22: 474.

The authors investigated experimentally the variations of the total and free cholesterol content of whole blood and plasma in dogs, in the following groups: normal and thyroidectomized dogs, and normal or thyroidectomized dogs that had been fed thyroxin.

Following thyroidectomy, the total and free cholesterol content of the plasma was increased, but the red cells showed no increase. If such dogs received thyroxin, the cholesterol level returned to the pre-operative level. If thyroxin was discontinued the hypercholesterolemia recurred, but very slowly.

Normal dogs, when fed thyroxin, showed insignificant variations in either the total or free cholesterol level.

At present there is no satisfactory explanation for the increase in the plasma cholesterol. It may be due to the rate at which these substances are synthesized, excreted, or oxidized, or to the rate at which transported fatty acids are oxidized or stored.

FRED S. MODERN, M.D.

Goetsch, E.: Hygroma Colli Cysticum and Hygroma Axillare: Pathological and Clinical Study, and Report of 12 Cases. *Arch. Surg.*, 1938, 36: 394.

The author reports a detailed clinical and pathological study of 12 cases of cystic hygroma. In 10 the growth involved primarily the cervical region, and in 2, the axilla.

From a thorough review of the literature and a thoughtful consideration of the etiology of cystic hygroma, the plausible theory is that it arises from sequestrations of lymphatic tissue. In cases of cervical hygroma such sequestrations are derived from the primitive jugular sacs, which have failed to join the lymphatic system in the normal manner. Their potentiality of increasing in size to an almost unlimited extent is due to the fact that these "lymphatic rests" retain their embryonic power of irregular growth.

Predisposing or exciting causes of cystic hygroma are not known.

In the average case, there are no local or constitutional symptoms, although there may be cosmetic disfigurement. Symptoms may develop, however, in cases of advanced uncomplicated involvement as a result of pressure on important structures, such as the trachea, pharynx, and nerve plexuses. Severe respiratory embarrassment may occur when the tumor extends into the mediastinum. The large hygroma has a tendency to become infected secondarily, and the infection may be followed by serious symptoms or even death. Anemia and a poor nutritional condition are occasionally noted in children.

Hygroma is a benign, true neoplastic tumor of lymphatic origin. It is a multilobular, multilocular cystic tumor, the cavities of which are lined by endothelium characteristic of lymphatic spaces. The fluid content is usually clear or straw colored, occasionally turbid or bloodstained. It is practically free of albumin or globulin and does not coagulate on standing. Various types of leucocytes, phagocytes, fragmented nuclei, and cellular débris are noted in specimens which have been centrifuged; cholesterol crystals occur in cases in which there is hemorrhage. Lymphoid tissue, in fact, germinating centers and

possibly lymph glands, are formed in abundance in cystic tumors.

Histological evidence is offered as a basis for the explanation of the manner of growth, development, and destructive action of hygromas. Endothelial fibrillar membranes or sprouts from the walls of the marginal cysts penetrate the adjacent normal tissues. A lymph-like fluid is secreted within the fibrils, which are thereby caused to spread apart and canalize. Minute cysts with an endothelial lining are thus formed within these sprouts. By continued secretion within, the cysts enlarge; by pressure atrophy of the walls between adjoining cysts, the large cavities characteristic of hygroma are formed. The fibrillar membranes infiltrate and circumscribe adjacent tissues. Muscle fibers, nerves, or other anatomical units are thereby sequestrated and destroyed, either by direct atrophy and fatty degeneration, or by being engulfed and disintegrated in the cystic fluid formed about them.

In the past, diagnosis has often been difficult and confusing, particularly with the more deeply situated tumors. They have been confused with lipomas, branchiogenous cysts, hematomas, angiomas, and tuberculous adenitis. When the true characteristics of these tumors are kept in mind, diagnostic errors should be relatively few. A positive clinical diagnosis can usually be made on the basis of the history and the physical examination.

Early treatment is advisable. Minor surgical procedures sometimes adopted include aspiration, simple incision for drainage, and injection of sclerosing substances. Such procedures are futile in view of the multilocular nature of the tumors and the great danger of secondary infection with severe sepsis. Irradiation has been practiced in the past with indifferent results. For very large tumors in children under six or eight months of age, irradiation preliminary to surgical treatment is desirable. Secondary surgical excision, however, is still necessary for cure. Radical surgical excision is by all means the treatment of choice.

There was but 1 fatality in this series, although the mortality after surgical removal of hygroma has been rather high in the past. The immediate and ultimate results were excellent cosmetically and as regards complications.

In 1 case there was a recurrence of the growth five months after the first operation. Late results following operation for hygroma were observed in 5 instances over periods of from ten months to ten and one-half years. In a case of partial excision of a hygroma which was subsequently treated by high voltage roentgen therapy, the patient, a child, was in good condition fourteen months after operation. In the remaining 5 cases the immediate result was satisfactory, but a late "follow-up" study was not possible.

JOHN H. GARLOCK, M.D.

SURGERY OF THE NERVOUS SYSTEM

BRAIN AND ITS COVERINGS; CRANIAL NERVES

White, J. C., Sweet, W. H., and Hurwitt, E. S.: Water Balance in Neurosurgical Patients. *Ann. Surg.*, 1938, 107: 438.

In the consideration of fluid loss in neurosurgical patients, it is noted that the same factors which are present in ordinary surgical patients, plus several other important factors, operate in these patients. The blood loss is considerably greater and the cavity is closed, so that changes in the serum protein levels, with the accompanying tendency toward the formation of tissue edema, play a vastly more important rôle. It is unfortunate that there are no accurate indices of early dehydration. Besides the well known clinical signs, the most important laboratory data are: (1) the urine volume and specific gravity; (2) the red-blood count, hemoglobin and hematocrit determinations; (3) the serum protein; (4) the non-protein nitrogen; (5) the body weight, and (6) the blood volume. The authors have used the first 4 methods, none of which was found to be infallible until the dehydration had reached the advanced stages and the blood volume had begun to fall. One can safeguard the water balance more effectively by appreciating the fluid needs of the patient than by the most careful watching for signs of dehydration.

The importance of insensible water loss during and after operation cannot be emphasized too strongly because of the large volume and because, if it is not recognized and adequately replaced, it will continue until there is no water left for renal secretion. To reduce the water loss during neurosurgical operations the use of ether should be avoided whenever possible; the temperature of the operating room should not be allowed to go above 80° F., and the lightest possible drapes should be employed. In order to combat the fluid loss which is generally more than 1,000 c.cm., and may exceed 2.5 liters, an infusion of 5 per cent glucose in saline solution is started at the outset of the operation. This may be fortified with citrated blood if the condition of the patient requires it. After operation the intravenous infusion is continued on the ward and a total of 2,000 c.cm. of the solution is slowly given during the next four hours. This is all that should be given on the day of operation as the use of more would involve the danger of cerebral edema, which is a very real danger in patients who have had their serum protein depleted by inadequate diet or through vomiting prior to operation. The serum protein level must always be elevated to above 5.6 per cent prior to the time of operation. This may be accomplished by transfusion, or by giving the patient a diet that is high in protein.

Edema resulting from the use of too much salt solution is a serious possibility and for this reason the use of glucose in saline solution is limited to the day of operation. Thereafter, if the patient is comatose, glucose in sterile water is used. For the most part, neurosurgical patients are able to take fluids by mouth in adequate quantities. If they do not require a limited intake, they should have from 1.5 to 2 liters of fluids daily. If fever is present, the intake should be raised accordingly up to 2.5 liters. Generally speaking, the specific gravity of the urine should be kept below 1:025. Such intakes of fluid are above those recommended by Fay, and distinctly below those recommended by Coller and Maddock for general surgical patients. Granted, however, that the surgeon recognizes the narrow margin of safety and is willing to follow up his patient with the quantitative tests outlined above, it is believed that a limited degree of hydration is much safer after operative trauma to the brain than any excess of fluid.

JOHN WILTSIE EPTON, M.D.

Hasenjaeger, T., and Spatz, H.: Localized Changes in the Configuration of the Brain in Cases of Intracranial Pressure. Obliterative Swelling of the Cisternæ and Displacement Across the Midline (Ueber oertliche Veraenderungen der Konfiguration des Gehirns beim Hirndruck. Zisternenverquellung und Verschiebung ueber die Medianebene). *Arch. f. Psychiat.*, 1937, 107: 193.

The brain is a plastic mass, which, in the presence of expanding processes, undergoes a variety of alterations in form, such for example as indentations and protrusions. These deformations are frequently accompanied by swelling of the brain. However, a differentiation must be made between localized and generalized swellings of the brain. Local changes of configuration occur at points where extensive external (subarachnoid), liquor-containing spaces exist, viz., the cisternæ. Spatz and Stroescu distinguish 6 cisternæ: (1) the cisterna magna cerebello-medullaris; (2) the ponto-medullaris, (3) the basalis, (4) the ambiens, (5) the fossæ sylvii, and (6) the interhemispherica. A constant relationship subsists between the cisternæ and the herniating brain parts. By the term "obliterative swelling" (Zisternenverquellung) the authors mean the protruding of a part of the brain into the cavity of the cisterna which empties the latter of fluid. The liquor in these spaces communicates with the various cisternæ themselves and with the subarachnoid spaces of the spine. The cysternæ ambiens, fissuræ sylvii, and interhemispherica correspond to the three great fissures of the brain, viz., the fissura transversa, fossæ sylvii, and fissura interhemispherica. In these sulci lie the main arteries of the brain: arteria cerebri posterior, media, and anterior. In the cisterna

basalis, in which are united the other three cisternæ, lies the circulus arteriosus willisii. The authors describe the herniation of the brain-parts across the midline with photographs and schematic drawings in tumor cases. They discuss the cerebellar tonsils (amygdalæ cerebelli) and their importance to the brain-surgeon in locating the side of the pathology. This phenomenon is not an anatomical anomaly (Arnold). In their opinion a local increase occurs in the volume of the amygdalæ and of the medulla oblongata, whereby these structures fill out the available space within the foramen magnum, viz., the cisterna magna. These enlargements of the tonsil might be a part of a generalized swelling of the brain, or, according to Toennis, they may be the result of local circulatory disturbances.

The authors now discuss the herniation across the midline, "the ring of the protuberating gyri," produced by the enlargement of these gyri. This "ring" is not due solely to the expansive pressure from the tumor since it is found in cases where no expanding process is present. In cases of unilateral tumor of the cerebral hemisphere, the parts of the brain within the ring of the cysternæ are pushed across the midline and present a fungus-like appearance. From this fact it can be seen that the falx cerebri as well as the insertion of the infundibulum of the hypophysis is fixed, and only those parts of the brain lying between these two can take part in the herniation, and the protrusion is most pronounced in the middle. However, the hypophyseal infundibulum is placed on a slant as its origin on the tuber cinereum is carried along by the protrusion process while its insertion on the sella turcica remains fast. The epiphysis which is usually calcified may also assume a slanting posture but to a much less pronounced degree. It is noteworthy that, contrary to what one would assume, the part of the midbrain which is subjected to the pressure is not decreased but rather increased in size. Very excellent photographs and drawings show these displacements as seen from below. There are also 2 pictures taken from the front, the more common exposure.

Cisternal obliterative swelling also occurs, however, in the absence of a brain tumor, as for example, in catatonia (Reichardt) and in epilepsy. However, in these conditions the obliterative process in the cisterna is less pronounced. The diagnosis of swelling of the brain can be made only by means of Reichardt's method. The problem of local brain swellings is still unsolved.

What then do these anatomical findings signify in relation to clinical matters? The displacement across the midline is clearly depicted in the ventriculogram, and in the arteriogram in the frontooccipital diameter. The obliterative swelling process is particularly noticeable in the regions of the cisternæ magna and ambiens, in the former at the level of the foramen magnum, and in the latter at the incisura tentorii. At both these places important portions of the neural tube were compressed, the medulla oblongata by means of the cerebellar pressure cone, and the midbrain by the tentorial pressure cone. The general manifestations of intracranial pressure are mostly local symptoms, as shown especially in cases of disturbance of the medulla oblongata with its vasomotor, vomiting, and respiratory-center disturbances. As these structures also take part in the swelling process, this swelling, in turn, increases the amount of pressure on them. The displacements in the region of the cisterna ambiens lead to damage to the region of the peduncles, the corpora quadrigemina, and the arteria cerebri posterior. An important remote symptom is the strangulation of the nervus abducens (Cushing) by one of the lateral branches of the arteria basilaris, whereby many of the instances of abducens paresis in brain tumor may be explained; apparently this phenomenon is essentially a process of obliterative swelling in the cisterna ponto-medullaris. Interesting is the observation of Bailey: operative manipulations under local anesthesia, carried on in the region of the incisura tentorii, give rise to intense frontal headaches. This fact may prove of diagnostic significance in patients with brain tumor who complain of only frontal headaches. The important thing in all these cases of obliterative swelling is that both lumbar and cisternal puncture be strictly prohibited. (Franz). John W. Brennan, M.D.

Berblinger, W.: Adenomas of the Pituitary Gland. (Die Adenome der Hypophyse). *Nervenarzt*, 1936, 9: 329.

While gliomas springing from the posterior lobe of the pituitary gland are quite rare, adenomas which arise primarily in the adenohypophysis are much more frequent. However, the epithelial cells of the adenomas are not always so far matured that the diagnosis of mother-cell, eosinophil-cell, or basophil-cell adenoma can be made from preponderance of one or the other of the three cell forms found in the adenohypophysis. Non-differentiated malignant adenomas can be distinguished from fully differentiated benign adenomas; however, the designation "hypophyseal cancer" is not properly applicable to the former. Only perihypophyseal tumors growing into the gland and hematogenous metastases of other primary carcinomas, especially mammary-gland and pulmonary carcinomas, cause cancer here.

The author reviews the subject of primary adenoma of the anterior lobe. He finds that eosinophil adenomas occur with the same frequency as the basophil variety. Clinically, the former, and probably also the latter (Cushing's disease), are significant because they cause increased hormonal action. It is regarded as questionable whether there is an increased normal action in the case of the mother-cell adenomas also. More probably these tumors lead secondarily to disturbances of function of the anterior lobe, usually in the sense of diminution of the organ activity, by pushing aside the chromophil epithelial cells or pressing on the hypophyseal stem.

This may also be done in the same way by tumors of the craniopharyngeal canal, which of themselves are incapable of internal secretion.

Of the effects of adenomas of the pituitary gland, the author mentions first the pressure effects, general intracranial pressure and the local pressure effects. General intracranial pressure always occurs late in cases of pituitary tumor, after the manifestation of local pressure effects; it is a chronic pressure. Not only a disturbance of the cerebral circulation, an anemia of the brain, plays a rôle in its pathogenesis, but also a certain condition of the brain the nature of which is as yet wholly unknown. It is not the same as cerebral edema, nor is it caused merely by an increase of fluid brought about by the hydrophilic colloids of the brain (brain swelling according to Reichardt). The anatomical bony changes in the sella turcica which develop as a consequence of local pressure are well known. The author investigated the extent of these changes in 25 cases of adenoma. Some may be recognized in the roentgen picture during life. It is only after the adenoma grows out over the sella turcica that pressure injuries occur in the region of the optic chiasm, manifested by bitemporal hemianopsia. The inconstancy of the visual disturbances is explained by the changes in the pressure exerted by the tumor. Softenings, which occur so frequently in these tumors, cause the pressure to diminish, and hemorrhages into the tumor tissue cause it to increase. Even when pressure is of long standing the result is not necessarily irreparable injury to the fibers of the ocular nerve; the disappearance of the medullary sheath is irregular. In spite of the frequently bitemporal loss of color of the papilla and the ocular nerve atrophy, bilateral choked disk is not generally present, even in the presence of large pituitary tumors. Injury to the ocular nerve is possible also from a suprasellar adenoma growing into the basal corona vascularis. It can also cause a reduction of the amount of blood in the arteries and thereby reduce the blood supply to the brain, which result is manifested clinically by a marked desire for sleep. Furthermore, the oculomotor nerve can be injured by local pressure, and paralyses of the eye muscles take place. It is of interest to note that fatal hemorrhages into the basal meninges may follow puncture of the pituitary gland.

Great attention must be paid to the hormonal effects proceeding from the adenomas and to the disturbances of pituitary function. In these particulars the eosinophil adenomas, which produce the picture of acromegaly, are best understood. The eosinophils produce the growth hormone, and probably also the thyreotropic hormone, in the author's opinion. The enlargement of the suprarenal cortex in acromegaly is regarded by the author not as due to the action of a corticotropic anterior lobe hormone, but as a part of the picture of a general splanchnomegaly. An increased secretion of thyreotropic hormone would explain the exophthalmic goiter symptoms, which are not unusual in acromegaly; similarly, the disturbances of the carbohydrate metabolism which are frequently found in acromegaly might be explained by an increased secretion of a hormone with an action contrary to that of insulin. In many cases the capacity to secrete the specific hormone becomes exhausted, the exaggerated growth impulse is checked, and the other symptoms are arrested in development. The genital disturbances of acromegaly, amenorrhea and impotence, are by no means early symptoms of the disease. They could be explained by partial hypopituitarism, which is caused, on the one hand, by the gradual suppression of the basophil cells, which produce the gonadotropic internal secretions which activate the genital glands; and, on the other hand, by the eosinophil cells, the action of the gonadotropic secretion being weakened by the growth hormone. The basophil adenomas never attain the size of the adenomas in acromegaly. Cushing has given a detailed description of the disease picture to which they give rise. It is characterized by a peculiar form of obesity, hypertrichosis, striæ cutis distensæ, a considerable and usually permanent arterial hypertension without disturbance of renal function, and osteoporosis. When the tumors do not spread above the sella, local pressure effects seldom occur. The pathogenetic importance of the enlargement of the suprarenal cortex, often found in this disease, has never been made clear. The author believes that it is the consequence of a basophil-cell hyperpituitarism. The individual symptoms of the disease are still difficult of explanation. This statement holds particularly for the osteoporosis which, with arterial hypertension, is considered one of the most significant changes in the disease; clinically, the osteoporosis may be manifested as kyphosis of the spinal column.

Concerning the hormone production of the basophil epithelial cells of the anterior lobe of the pituitary gland, one cannot speak with as much certainty as of the production of the growth hormone by the eosinophil cells. The author believes that it is suggested that the hormones which initiate activity of the sex hormones, the melanophore hormone, the interrenotropic hormone, and also vasopressin or tonephin arise in the basophil cells. We are not dealing with basically different internal secretions. Furthermore, these secretions do not act directly by way of the blood, but by way of the sympathetic nerve centers at the base of the midbrain. Pathogenetically, Cushing's disease might be regarded as hypophyseal basophilism.

Mother-cell adenomas are the most frequent type of adenoma of the pituitary gland. Can hormonal activity be ascribed to them also? There is no particular disease picture which corresponds to adenoma of these chromophobic epithelial cells. Clinically, they give rise to symptoms of hypofunction of the gland. Mother-cell adenomas frequently spread into the suprasellar region, sometimes into the third ventricle. In contrast to their manner of spread is that of the eosinophil adenomas, which extend

downward and forward. The chief disturbances caused by mother-cell adenomas are genital dystrophy and adiposity, but the latter may be absent. If growth in height has not yet ceased, short stature is added to dystrophia adipogenitalis. The genital disturbances (amenorrhea or impotence) are not the expression of basophil-cell partial hypopituitarism: the basophil epithelial cells are greatly reduced in number by the adenoma (even physiologically the basophil cells are much less numerous than cells of other types). Pressure on the metabolic center in the midbrain cannot be the sole determining factor of the adiposity. Much remains unclarified in the pathogenesis of the adiposity. It is possible to distinguish purely hypophyseal and cerebral, more exactly diencephalic, forms of dystrophia adiposogenitalis. Summarizing, one may say that in the case of dystrophia adiposogenitalis, as in that of Simmonds' disease, the cause is not to be sought in the hormonal activities of the adenoma cells, but in the consequences of injury to the normal cells of the anterior lobe. The author refuses to ascribe hormonal activities to the cells of the mother-cell adenomas and believes that even the normal mother cells probably do not produce hormones. The mother cells are to be regarded as outlet cells for the chromophil cells which develop from them.

In his conclusion, Berblinger reports his observations as a pathologist in respect to the various therapeutic methods. Mention has already been made of the danger of puncture of the pituitary gland. Emphasis is placed on the great danger of the occurrence of suppurative meningitis following operation by the endonasal route; three deaths from meningitis of this origin are reported. In the opinion of the author, in every irradiation of adenomas account must be taken of the fact that with the disintegration of the tumor (adenoma cells are more radiosensitive than normal epithelial cells of the pituitary gland) extensive capillary hemorrhages occur, which lead to renewed enlargement of the tumor and further pressure. Also, portions of the pituitary gland which have remained normal may be endangered by the irradiation. In operating on adenomas one should always think of the preservation of pituitary tissue capable of carrying on function. (HANS HANKE). FLORENCE A. CARPENTER.

Lysholm, E.: Radiological Experience in Ventriculography. *Brit. J. Radiol.*, 1938, 11: 273.

From a large series of cases, 3,285, studied by means of air or lipiodol injection into the ventricles or into the lumbar canal, and another smaller series studied by arteriography, the author has selected 806 cases verified by ventriculography for this paper.

A small amount of air was injected and many pictures were taken with the air bubble in various parts of the ventricular system. Stereoscopy was not used but a biplane exposure has been perfected which calls for a special radiographic technique. The purpose, of course, was to obtain information regarding the exact localization of tumors.

Fig. 1. Parasagittal tumor. The ventricular system is displaced, and the septum and the third ventricle are inclined from the tumor side, but remain nearly in line with one another. A line drawn through the septum and the third ventricle makes, with the mid-vertical line of the skull an angle open upwards. The lateral ventricle on the tumor side is compressed from above, and the other lateral ventricle is somewhat distorted, *i.e.*, flattened from side to side and elongated upwards.

The author lays great stress on the filling and alteration in position of the temporal horn in temporal lobe, and indeed all supratentorial, tumors. He also believes that he can determine the operability of tumors in the posterior part of the third ventricle. The method seems particularly applicable to small parasagittal tumors. ADRIEN VERBRUGGHEN, M.D.

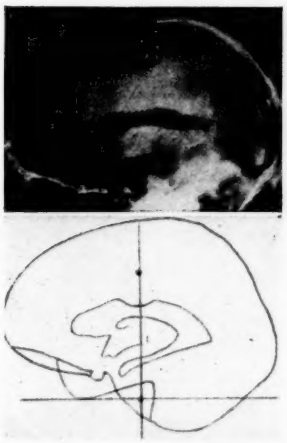

Fig. 2. Parasagittal tumor.

PERIPHERAL NERVES

Leriche, R.: The Surgical Treatment of Essential Hypertension (Réflexions sur le traitement chirurgical de l'hypertension artérielle solitaire). *Presse méd.*, Par., 1938, 46: 489.

Leriche operated upon 19 patients with essential hypertension. Though this is a small series compared to the large numbers of cases treated operatively in America, or to the frequency of the disease itself, he believes he can draw valuable conclusions from them as an aid in orientation in the problem, since he knows his patients personally and has followed them for a long time.

He has found that the results of unilateral splanchnicectomy were transient and practically valueless, and that the bilateral operation, while giving somewhat more lasting results, never produced a true or permanent cure. Adrenalectomy alone effected only "half a cure"! The author has had his best results from a unilateral adrenalectomy and lumbar ganglionectomy on the same side at one stage, followed by a section of the splanchnic nerves on the other side, with or without ganglion ablation on that side.

His outlook at present on the surgical treatment of hypertension is one of some doubt, and he seems to see more contra-indications than indications for surgery. He believes that the steady progression of the disease (over a period set aside for observation) is a contra-indication to surgery, since, hypertension being a *symptom*, the basic causative factor is progressive. He feels that the solution of the problem lies in the eventual understanding of the hormonal (adrenal) factor in the disease. He believes that it is to be solved by clinical rather than by experimental studies, for he thinks that the hypertension of human beings and that of experimental animals are entirely different matters and not to be compared either as to cause or as to results of surgical treatment.

JOHN MARTIN, M.D.

Page, I. H.: The Medical Aspects of Surgical Treatment of Hypertension. *J. Am. M. Ass.*, 1938, 110: 1161.

This report is a summary of the author's observations, experiences, and opinions concerning the surgical care of 29 hypertensive patients who were operated on by Heuer; Heuer performed a section of the anterior spinal nerve roots on 20 patients, and resected the lower thoracic ganglia and splanchnic nerves on the other 9.

Page has made a brief but distinct differentiation between the types of hypertension, essential and malignant, and indicates the protean nature of each. The patients were studied pre-operatively for a practical period, but as no criteria for the selection for surgery were known to the investigators, patients with various types of hypertension in various stages of the condition were chosen. The author found that the tests usually employed to determine vascular flexibility were not altogether reliable.

Anterior root section is a formidable operation, and when done by Heuer (usually in two stages), 3 unfortunate surgical accidents occurred. Young persons with essential hypertension and patients with malignant hypertension showed definite improvement after operation, but patients with older, longstanding cases did not seem to benefit by surgery, and it is Page's view that most patients with essential hypertension can still be treated best by medical means.

The patients on whom splanchnic nerve resections were done all responded with a marked drop in pressure for a matter of days or weeks, but by the end of nine months the pressure had returned to the approximate pre-operative level. With this operation subjective improvement was marked in most of the cases of essential hypertension, but in them, as well as in the cases of malignant hypertension, the effects were too transient to be called successful. The author believes that if a larger series of splanchnic resections could be studied, more favorable results, as compared to root section, might be expected. The relative simplicity of the operation speaks for its preference. He thinks that the surgical treatment of hypertension is still definitely experimental, that the results now being obtained are far from ideal, and, above all, that it is not at all certain what may be the theoretical basis for operation in cases of hypertension in which large vascular areas are denervated.

JOHN MARTIN, M.D.

SURGERY OF THE THORAX

TRACHEA, LUNGS, AND PLEURA

Decker, H. R.: Experience with Collapse Therapy for Pulmonary Tuberculosis in the Fifth and Sixth Decades. *J. Thoracic Surg.*, 1938, 7: 351.

The author presents the results of collapse therapy in a series of 154 patients between the ages of forty and sixty years. Of these, 135 were between forty and fifty years of age and 19 were beyond the age of fifty years. About 50 per cent of the patients had productive fibrous lesions, 25 per cent were found to have productive and exudative lesions combined, and 25 per cent were predominately exudative. In half of the cases, more than the equivalent of one lung was diseased. Cavitation was present in 69 per cent of the group, and 9 of every 10 cavities were apical, or were located in the upper lobe. From an economic standpoint, the earning capacity of these patients was zero.

A number of the patients refused the author's choice of procedure but accepted a less efficient one. In the cases of 114 patients, treatment was carried out for from six months to two years; in the cases of 25 patients, treatment was given for from two to five years; and in the cases of 15 patients, treatment extended over a period of from five to ten years.

The author found collapse therapy to be of great value for patients in the fifth and sixth decades of life. While good results are not obtained as frequently as might be anticipated in the cases of younger patients, yet a sizeable number are restored to health and earning capacity. Many successful results are obtained when least expected.

In discussing the various collapse procedures, the author states that artificial pneumothorax is possible to the point of satisfactory collapse in a much smaller percentage of patients after the age of forty, and selective collapse is less likely to be obtained because of the greater frequency of adherent pleuritis. Pneumothorax should be tried as a primary procedure before other methods of treatment because of its relative safety, but if a satisfactory collapse does not take place it should either be discontinued without delay, or should be supplemented by other types of operation.

Operation on the phrenic nerve has been more successful than any other method of treatment. However, in basilar pleuritis, because of the fixed diaphragm, little may be expected of phrenic nerve paralysis, nor is it to be expected that very thick-walled cavities in the midst of extensive productive lesions, or close to the periphery of the lung, will be influenced frequently by this procedure.

Plombage is a very valuable adjuvant in the treatment of patients in this age group, particularly in bilateral disease, and may easily accomplish at a minimal risk the same results produced by thoracoplasty. The author does not know how innocuous this paraffin pack will prove to be. From his observations, the pleura in patients with apical disease has proved to be thick and well fortified against perforation and its attendant complications. On the basis of his experience with individuals below the age of forty years, he believes that plombage is a valuable operation also for cavitation in the middle and lower lung fields.

Thoracoplasty is needed and should be utilized, but with greater precaution and hesitancy in this age group than in the earlier age groups. The fact that some mortality will occur and that the mortality rate will be higher than that in the earlier age groups should not be a deterrent to thoracoplasty, but should make one more willing to try other procedures first. There can be no question as to its value in the production of a most positive and expeditious form of collapse. EARL O. LATIMER, M.D.

Schenck, S. G., and Hochberg, L. A.: Clinico-roentgenological Considerations of Acute Thoracic Empyema. Thoracic Complications and Sequelæ in the Non-Tuberculous Form. *Am. J. Surg.*, 1938, 39: 561.

Difficulty and uncertainty are often experienced in eliciting physical signs in the chest of a patient with postoperative empyema. However, most of the complications and sequelæ which occur in acute empyema are readily demonstrable by roentgenograms of the chest.

X-ray examination is the most satisfactory method of determining the presence or absence of retained fluid, as well as the localization of pockets of pus. It makes the demonstration of adhesions relatively easy and gives considerable information regarding the appearance of the lung. It shows compression of the lung and the cause thereof. Pulmonary suppuration or abscess formation, and fistulous tracts between the pleura and bronchi can be seen by means of the x-rays, and observations on the mediastinum can be made. Mediastinal adhesions are characterized by a fixation of the mediastinum. Shifting of the mediastinum and the localization of pus can also be demonstrated.

The position of the heart may be affected by empyema, or purulent pericarditis may occur. Both of these conditions as well as variations in the diaphragm and the motility of the diaphragm can be observed by means of the x-rays. Observation of the ribs overlying the area of empyema may help to make an early diagnosis of osteomyelitis. The extent and size of a persistently draining sinus tract may be visualized after an injection of iodized oil, and spinal deviation may also be observed. Extraneous shadows caused by drainage tubes or a gauze sponge accidentally left in the chest are frequently valuable diagnostic signs.

The author believes that a careful systematic survey by roentgenography will explain and clarify the patient's clinical course. EARL GARSIDE, M.D.

Woodruff, W.: Tuberculous Empyema. *J. Thoracic Surg.*, 1938, 7: 420.

This paper is a report on a study of 154 patients under the care of 12 physicians. Of these, 134 had a follow-up of from three to eight years, and 20 of less than one year.

Tuberculous empyema is defined by the author as "any turbid pleural fluid in the presence of pulmonary tuberculosis, or any fluid containing tubercle bacilli on direct smear." There were 47 known persistent bronchopleural fistulas, and 42 known secondary infections. In 137 cases the empyema complicated an artificial pneumothorax. In 12 it began as pleurisy with effusion.

Of the entire series of 154 patients 64 are dead. The death rate was about 30 per cent in this uncontaminated tuberculous group and approximately double that for the mixed infections and for fistulas.

The progressive stages of a tuberculous pleuritis are recurrent serous effusions in pneumothorax for tuberculosis, seropurulent effusions, and thick tuberculous pus. At any stage there may be secondary infection or rupture to the outside, either through a bronchus or through the chest wall.

For the purpose of evaluating the treatment given in these cases, the author places all patients without secondary infection into Group A, and those with secondary infection into Group B. Aspiration only is of value in Group A; 40 per cent of the patients recovered without further treatment and 40 per cent died. It is of no value in Group B. Irrigation with salt solution and dyes was of some value in both groups, especially in Group B, in the preparation of patients for later thoracoplasty. Oleothorax was of great value in Group A, and 50 per cent of the patients recovered without further treatment; however, it was of no value in Group B. The use of the tube and thoracotomy are contraindicated in Group A, but they are frequently required in Group B. Of the patients 65 per cent are dead. Thoracoplasty is of great value in both Groups A and B. The better the patient's condition is and the thinner the pleura, the better are the end-results.

J. DANIEL WILLEMS, M.D.

Arce, J., Brea, M. M., and Taiana, J. A.: Primary Tumor of the Pleura (Tumor primitivo de la pleura). *Bol. inst. de clin. quir.*, Univ. de Buenos Aires, 1938, 14: 10.

The authors observed the case of a forty-nine-year-old Italian man, whose condition dated back to three years before, at which time he began to complain of pain localized at the base of the right thorax. He attributed this pain to a previously sustained cholecystectomy. There was no fever, cough, or expectoration.

On physical examination the patient presented an emphysematous chest, and on palpation he complained of pain along the seventh and eighth intercostal spaces on the right side especially at the level of the scapular line. Percussion of the right chest revealed the presence of a round zone of dullness of about 11 cm. in diameter located just below the inferior angle of the scapula and covering the seventh and eighth intercostal spaces. Auscultation revealed vesicular breathing throughout the chest. Roentgenological examination showed the presence of a rounded mass extending from the sixth to the eighth rib, well separated from the mediastinum and the diaphragm. The opacity was uniform and the ribs could be distinguished through it. In profile exposure the mass was found to lie distinctly posteriorly and it assumed a semi-oval aspect. With the aid of an artificial pneumothorax the mass was found to be non-displaceable. A diagnosis of intrathoracic tumor was made. Inasmuch as the tumor was evidently originating from the thoracic wall and because of the long clinical course of the condition, a primary fibrosarcoma of the pleura, possibly undergoing malignant transformation, was suspected.

Under novocaine anesthesia, a rib resection was performed and the pleural cavity was exposed at the level of the ninth intercostal space. The tenth rib was found to be free. During the operation the patient showed signs of collapse and he died thirty-six hours later. Autopsy showed fatty infiltration of the heart muscle and slight atheromatous changes of the aorta. Examination of the specimen removed at operation revealed a mass about the size of a small orange adherent to the resected rib. The tumor was enveloped in a fibrous capsule showing a plane of cleavage at the seventh and eighth ribs. The ribs appeared to be destroyed at the point of contact with the tumor.

Microscopic examination showed the presence of collagenic fibers and adult fibroblasts. The nuclear elements predominated over the fibers. The histopathological picture was that of a fibroma but there were a few characteristics of a neurofibroma (schwannoma) probably originating from an intercostal nerve.

In a discussion of this subject, the authors point out that small tumors of the pleura do not give rise to subjective complaints, and remain latent as a rule, but if they attain a large size, the patient presents definite symptoms. The rate of growth of neurofibromas is notoriously slow, whereas neurofibrosarcomas grow rapidly. The pain is usually localized at the site of the tumor and may radiate along the course of the involved nerves. Another important diagnostic sign of intrathoracic neurofibromas is the ease with which these tumors can be displaced.

Intrathoracic neurofibromas are rare but a few cases have been reported in the literature. The pathological diagnosis is often difficult because of the many possibilities of interpretation.

Treatment is always surgical. Considerable technical difficulties are encountered if the tumor mass is large. RICHARD E. SOMMA, M.D.

HEART AND PERICARDIUM

Basset: A.: A Case of Cardiac Symphysis Treated by Precordial Thoracectomy, Brauer's Operation; Result at the End of Two and One-Half Years. (A propos d'un cas de symphyse cardiaque traitée par la thoracectomie précordiale, opération de Brauer. Resultat au bout de deux ans et demi.) *Mém. l'Acad. de chir.*, Par. 1938, 64: 384.

Basset reports a case of cardiac symphysis in a young man twenty years of age, who at sixteen had had an acute febrile attack with pericardial involvement. From that time he had increasingly severe cyanosis, dyspnea, oliguria with ascites, hydrothorax, edema of the legs, and painful enlargement of the liver. Radiological examination showed nodular infiltration of both lungs; and there were recurrent attacks of fever. As medical treatment proved unavailing, operation was necessary. Precordial thoracectomy was done by Brauer's technique from the third to the sixth rib. Convalescence was complicated by two attacks of phlebitis, three short febrile periods, and one crisis of pulmonary edema. However, at the end of two years and a half, the patient's condition was definitely improved. The dyspnea and cyanosis were relieved and the edema had disappeared; the pulse was regular and the electrocardiogram more nearly normal; the size of the liver was reduced. The patient was not cured; his activities had to be limited, his daily régime carefully regulated, and medication resorted to from time to time.

Precordial thoracectomy for cardiac symphysis does not usually result in complete cure. The pain, dyspnea, and cyanosis are usually relieved promptly, but the edema, serous effusions, and the enlargement of the liver subside much more slowly and with occasional exacerbations. Patients who have been operated upon must be followed up for a long period, in order that the ultimate results may be determined. The immediate postoperative mortality is relatively small, but a larger percentage of patients dies within the first year, according to statistics given by various surgeons.

The resection should be sufficiently large and include at least four ribs; and in young patients at least, it should be extraperitoneal as in the author's case, in order that re-formation of the plastron may be prevented. The author states that results may be improved in cases in which there are adhesions between the pericardium and the diaphragm by the combination of phrenicectomy as a preliminary measure.

ALICE M. MEYERS.

Murray, G., Wilkinson, F. R., and MacKenzie, R.: Reconstruction of the Valves of the Heart. *Canadian M. Ass. J.*, 1938, 38: 317.

The work of these authors is a continuation of experiments on the cardiac circulation in the University of Toronto. This report is based on experiments in intracardiac surgery, in which the heart valves were resected and successfully replaced by venous grafts.

The lateral cusp of the mitral valve was resected by means of an approach to the valve through the apex of the auricle. Eight control animals died within six days, several within twelve hours. In 8 others, resection of the lateral mitral cusp was carried out, and in 6 of these the valve was immediately replaced by a venous graft. Two of these animals are alive and well six months after the operation.

The cardiovalvulotome was passed through a small opening in the apex of the left auricle, and a purse-string suture was tightened around the opening to prevent leakage of the blood. The instrument was passed through the mitral ring and the blade was allowed to open. The lateral cusp of the valve was picked up in the notch of the instrument and a piece of valve, from 8 to 10 mm., was excised and the instrument withdrawn. The opening in the auricle was closed with a ligature.

About 3½ in. of jugular vein were excised and turned inside out so that only the endothelial lining was in contact with the blood stream. A silk suture was attached to each end and with one of these the vein was drawn into a cannula, which was then passed through the anterior heart wall, across the cavity of the heart, to emerge on the posterior side of the left ventricle. The suture on the end of the vein was grasped, the cannula was withdrawn, and the vein was left across the cavity of the heart. The new valve was thereby placed in the heart so that it would lie in the line of the resected valve. Both ends of the new valve were sutured to the epicardium of the left ventricle.

Immediately following the placing of the new valve, the increasing dilatation and cyanosis of the heart ceased, the heart rate improved, and the cyanosis of the dog's tongue subsided.

During the resection of the valve in some of the animals, the ventricle began to fibrillate and the rhythm could not be restored. If resection of the valve had been carried out successfully, all the dogs would have survived the operation of placing the new valve. There are two surviving animals which are quite well, without signs of edema or heart failure. They can take their part with the other dogs in the runway. There are soft systolic murmurs in the hearts of both animals.

J. DANIEL WILLEMS, M.D.

MISCELLANEOUS

Gamble, H. A.: Tracheo-Esophageal Fistula. *Ann. Surg.*, 1938, 107: 701.

Gamble reports a case of congenital atresia of the esophagus with tracheo-esophageal fistula. This condition, although rare, is being recognized more frequently. All patients whose cases have been reported have ultimately succumbed, most of them dying within the first fortnight. The surgical procedures previously attempted are reviewed, beginning with Richter's operation in 1913; and the operation of Mixter, Gage, and Levens is mentioned.

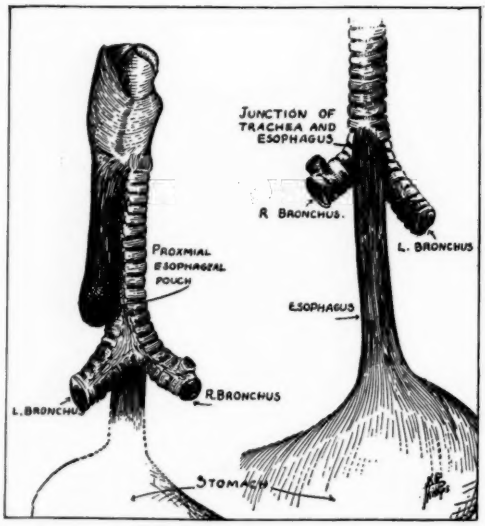

Fig. 1. Sketch showing anatomical relations found at autopsy. The proximal esophageal pouch ended blindly posterior to the trachea, just above the bifurcation. At the same time there was a fistulous communication between the anterior surface of the trachea and the distal segment of the esophagus. (Courtesy of J. B. Lippincott Co.)

The surgical approach to this problem is either by direct or indirect attack of the lesion. For the latter method at least three stages are necessary. The objects in the first stage are: (1) to provide means for nourishment; (2) to prevent regurgitation of food; and (3) to prevent pulmonary complications. The second stage is concerned with the reconstruction of the esophagus, and the third stage deals with the re-establishment of the continuity of the gastro-intestinal tract.

An ingenious operation, designed to fulfill the above requirements, was performed by Gamble in the case presented. The stomach was delivered through an incision to the left of the midline and completely transected at its upper fourth between small modified Payr clamps. The proximal end of the distal segment was then completely closed and a gastrostomy of the Stamm type accomplished at the same time, the gastrostomy tube being brought out through a stab wound to the left of the incision. In this manner regurgitation of the food into the lungs was completely eliminated. The site for division at the upper fourth of the stomach was selected in order that the esophageal end of the stomach would have a sufficient amount of stomach tissue left to enable one finally, after ultimate reconstruction of the esophagus, to re-establish the continuity of the gastro-intestinal tract by anastomosing the two segments of stomach. The proximal fourth of the stomach was then brought out at the upper angle of the wound and after closure of the incision the Payr clamps were removed and the stump was sutured to the skin. This is an important step toward the prevention of pulmonary complications, as it provides free drainage of the whole bronchial tree. It is surprising to note the large amount of fluid that drains from this esophageal stump. Any operation which closes the esophagus creates a blind pouch which rapidly fills with secretions, which inevitably regurgitate into the lungs and are an active factor in the causation of the pulmonary complications from which most of these patients succumb. The provision for free drainage is an essential feature of the operation. An esophagostomy of the proximal esophagus later removes any further menace to the lungs.

The infant, unfortunately, developed bleeding from the wound, which necessitated re-opening, and at that time a bleeding point was found on the lesser curvature of the stomach. This was secured and ligated, but death occurred on the fifteenth day. Autopsy disclosed general peritonitis secondary to the perforation of an ulcer on the anterior wall of the stomach. The lungs were not involved in any way.

This case demonstrates the practicability of transection of the stomach to prevent regurgitation, and the benefits accruing from drainage of the esophagus in the prevention of pulmonary complications.

JACOB M. MORA, M.D.

PERITONITIS

A Collective Review of the Significant Literature for Six and One-Half Years

HAROLD D. HARVEY, M.D., and FRANK L. MELENEY, M.D., F.A.C.S., New York, New York

IN July 1931 one of us attempted to review the recent significant literature on the subject of peritonitis. The report appeared in Nelson's *Loose-Leaf Surgery, Surveys of Current Literature* (93). The present article has continued the study up to the end of 1937. During these six and one-half years, over 1,500 articles relating to peritonitis have appeared in medical journals. This statement indicates that there is widespread interest in a problem which is far from being solved. It is a complex problem with many facets, involving questions, not only concerning the membrane itself, which is an extensive serous surface equal in area to the surface of the skin, but concerning the function of the numerous contained organs. In spite of the large number of articles which has appeared, there are only a few significant advances in our knowledge of this extremely important phase of general surgery. Although these reports cover very much the same ground indicated by our previous review, there is a somewhat altered emphasis. Much more attention is being paid to the prophylactic measures which may be applied to peritonitis by means of various vaccines, and to special measures for its cure, particularly by means of sera and ultra-violet light. The papers in general group themselves under the following headings:

I. Anatomy
II. Physiology
III. Pharmacology and chemistry
IV. Bacteriology
V. Clinical aspects
VI. Prophylactic treatment
  A. Vaccine
  B. Amniotic fluid
  C. Filtrate
  D. Bacteriophage
  E. Miscellaneous
VII. Active treatment
  A. Operative
  B. General
  C. Serum
  D. Bacteriophage
  E. Ultra-violet light

From the Bacteriological Research Laboratories of the Department of Surgery, Columbia University, College of Physicians and Surgeons, and the Presbyterian Hospital, New York City.

I. ANATOMY

The question of the routes of spread of free fluid coming from a perforated viscus within the peritoneal cavity has been reviewed by Pantin (117). The routes he describes are: (a) from a perforated duodenal ulcer to the right flank and right diaphragm with right shoulder pain; (b) from a high gastric ulcer to the left flank and diaphragm, with left shoulder pain usually appearing later than the abdominal pain; (c) from a gastrojejunal ulcer along the right side of the mesentery into the right lower quadrant; (d) from a ruptured ectopic pregnancy through either flank to the diaphragm; (e) from a ruptured spleen to the left diaphragm, with pain first in the shoulder and then in the flank. All of the symptoms in such cases are based on anatomical arrangements within the abdominal cavity.

Allen (2) has photographed frogs' red blood corpuscles entering stomas in the diaphragms of mice after intraperitoneal injection. He was not able to demonstrate stomas anywhere except in the diaphragm and is of the opinion that they are open when the diaphragm is relaxed, and are closed by the contraction of this muscle.

This work is partly confirmed by the observations of Menkes (97) who injected a colloidal suspension of thorium dioxide into the peritoneal cavity of guinea pigs and rabbits, and took x-ray films at various intervals. Immediately after the injection, the material spread uniformly throughout the peritoneal cavity and after from three to five hours the lymphatic vessels were outlined in the anterior cupola of the diaphragm, and were shown to converge into two parallel lines leading to the retrosternal nodes and intercostal lymphatics.

II. PHYSIOLOGY

A. Absorption of solutions and particulate matter.

Many investigators have injected various materials into the peritoneal cavity and have made observations on the physiology of peritoneal absorption of both solutions and suspensions of insoluble material. Many of these studies were made under conditions that do not occur in real life and the authors' conclusions are based on two questionable premises: first, that the substances injected behave in a manner similar to solutions

or suspensions which do occur in the peritoneal cavity, and, second, that the method of absorption in man and animals is the same. In general the authors determined the route of absorption by a study of the lymph from the thoracic duct and the blood from the portal vein.

Schechter (147) believes that, in the uninflamed peritoneal cavity, the laws of diffusion and osmosis govern the absorption of substances other than proteins. The mechanism of the absorption of proteins is not yet established. When normal saline, glucose, or salt-bicarbonate solutions were injected into the peritoneal cavity, they all gradually took on the electrolytic composition of edema fluid and were absorbed at a constant rate.

Sato (145) believes that soluble substances are absorbed by the blood stream, and particulate matter by the lymphatics, especially those of the omentum and diaphragm. When these systems are blocked, there is no delay in the absorption of soluble substances, but there is a delay in the absorption of particulate matter.

The results of De Vincentiis (32) are somewhat different from those of Sato, as he observed that the removal of the omentum delayed the absorption of certain solutions, but did not consistently delay the absorption of organisms.

Teshima (180) confirmed the absorption of particulate matter by the lymphatics of the diaphragm and found that the process went on for an hour and a half after the death of his animals.

Mengle (96) found that the absorption of particulate matter was more rapid under ether anesthesia than under sodium-amytal or local anesthesia, probably because of the activity of the diaphragm, and Friedrich (42) concluded that absorption was dependent upon heart action, tonus of the splanchnic vessels, peristalsis, and respiration.

Laird (89) observed that substances such as arsenic, phosphorus, and sodium iodide injected intraperitoneally all produced a fatty infiltration of the liver and that this action could be greatly delayed by ligation of the portal vein.

Pierini (123) found that phenolphthalein injected into the peritoneal cavity was rapidly eliminated in the urine without appearing in the lymph, and that this absorption was delayed if the drug was mixed with hypertonic saline solution, which caused a large exudation of fluid into the peritoneal cavity.

B. Absorption of bacteria.

Risi (140) is of the opinion that bacteria are absorbed both by the lymphatic system and the blood, and disappear from the blood earlier than from the lymphatic system.

Gucci (51), after injecting colon bacilli into the peritoneal cavity, recovered them from the thoracic duct in from ten to twenty minutes, and from the blood in from twenty to thirty minutes, even when he canalized the thoracic duct to prevent contamination of the blood stream from that source. (Note: He could not of course be sure that he had thus blocked off all the lymphatic routes to the blood stream.) Bacteria appeared in the liver and spleen in from fifteen to thirty minutes. (The route to the spleen is not easily understood, except either through the blood stream or through the peritoneum directly.) If he first produced peritonitis in his dogs by injecting turpentine one or two days before the injection of colon bacilli, he found that he obtained no growth either from the thoracic duct or from the blood stream although the organisms were still present in the peritoneal cavity. With mild peritonitis, produced with weaker emulsions of turpentine, he obtained sterile blood cultures but found bacteria in the thoracic ducts, which findings suggested a block of the routes into the blood.

Finucci (38) likewise found bacteria in both the portal vein and thoracic duct in less than five minutes after the injection.

These experiments indicate that absorption of bacteria and other particulate matter commonly occurs by way of the lymphatics, and of solutions or even large molecules by way of the blood stream. Whether the latter enter the lymphatics first is not known, nor is the method of passage of any substance from the peritoneal cavity to the lymph or blood stream explained. It seems established that the inflamed peritoneum absorbs usually less actively than the uninflamed and that substances in solution are absorbed best when isotonic.

C. Cellular reaction.

A number of authors have studied the cellular reaction of the peritoneum to the injection of various substances. All are agreed that the polymorphonuclear leucocytes are normally present in very small numbers, the chief cells in the normal peritoneal fluid being large phagocytic mononuclear cells.

Dixon and Rixford (35) estimated these cells in man to be in the neighborhood of 2,000 per c.mm. Webb (191) and others have found that with the injection of almost any substance, either in solution or suspension, there is a prompt development of an exudate containing a large proportion of polymorphonuclear leucocytes. Some of the authors have apparently not been aware of the importance of an accurate determination of the time after injection at which the examina-

tion is made, or have ignored the dilution factor of the fluid portion of the exudate.

Seeley, Higgins, Mann, and Dixon (156), however, working with rats, determined the total number of peritoneal cells by counting the number of each type in each c.mm. and by weighing blotting paper before and after absorption of the total peritoneal fluid. Their total counts were: mononuclears, 18,000,000; eosinophiles, 3,000,000; basophiles, 1,000,000, and neutrophiles, 18,000. They injected amniotic fluid concentrate, Bargen's colon bacilli and non-hemolytic streptococcus vaccine, and 2 per cent ricinoleate. After all injections, the polymorphonuclear leucocytes increased rapidly and reached a peak in from three to six hours. The mononuclears, on the other hand, increased gradually for a period of six days. The ricinoleate gave the most striking effect.

Similar work was done by Corwin (25, 26) who found that the cells increased from 1,800 to over 100,000 per c.mm. after injection of Bargen's vaccine. Whereas the count per cubic millimeter after injection of sodium ricinoleate was only 40,000, the total amount of fluid was so much greater that a greater total number of cells was evoked by the ricinoleate than by Bargen's vaccine.

Pons, Gannon, and Belk (125) found that while the leucocytes were pouring into the peritoneal cavity after the intraperitoneal injection of bacillus coli vaccines in 2½ per cent gum tragacanth, there was a fall in the leucocytes of the peripheral blood. The same result was obtained with 5 per cent of aleuronat in gum tragacanth and the workers believe that this indicated a "withdrawal phenomenon."

D. Peristaltic function.

Namikawa (106) made certain observations on the peristaltic action of the gut. He found that almost any substance injected into the peritoneal cavity of animals slowed peristalsis, and electrical or mechanical stimulation of almost any part of the parietal peritoneum caused a reflex slowing of peristalsis, which could be prevented by cutting of the splanchnic nerves or by cutting of the cord at the second dorsal segment. After ligation of the blood vessels, stimulation of the splanchnic nerves produced no change in peristalsis, which suggested that the reflex passes through the sympathetics in the walls of the blood vessels.

Imanaga (70) placed glass windows in the abdominal walls of dogs and rabbits and observed peristalsis in the intestines following the intraperitoneal injection of certain irritating substances. When he injected Lugol's solution he found that the small gut went into spasm wherever the solution touched it. The spasm was followed by a local slowing of the blood stream and local atony of the gut. When he produced local peritonitis by the injection of bacteria, he likewise found a local slowing of peristalsis, which could be corrected by the intravenous administration of saline solution or blood. Only in diffuse peritonitis was the gut affected extensively. Imanaga believes that the lowered blood pressure in diffuse peritonitis and the subsequent slowing of the blood stream cause an accumulation of acid in the intestinal wall which is responsible for atony of the gut and loss of peristalsis. When he examined the blood of the portal vein in animals with diffuse peritonitis, he found a lower pH, a lower sodium chloride content, and a marked lowering of the oxygen content.

III. PHARMACOLOGY AND CHEMISTRY

A number of authors have studied the effect on distant parts of the body resulting from or following the injection of various materials into the peritoneal cavity.

A. Blood chemistry.

Hasama (58, 59) found that the blood sugar was increased in proportion to the degree of peritonitis, and that the adrenalin content of the blood and also of the adrenals was promptly elevated. On this basis, he believed that adrenalin was contra-indicated in peritonitis and that insulin should be used. Katsuragi (79, 79a), however, observed that the initial rise of adrenalin was followed by a fall, and this seemed to him to be a definite indication for the administration of adrenalin. Confirmatory evidence lay in the histological examination which revealed hemorrhages, fatty degeneration, and atrophy of the adrenal cells.

Hashimoto (60) found the same histological changes in the pancreas following peritonitis.

Tabanelli (178, 179) noted a fall in the cholesterol content of the blood, adrenals, and liver, but a rise in the cholesterol content of the spleen, in experimental animals suffering from peritonitis. In 33 patients with acute peritonitis, he recorded a fall in blood cholesterol, which continued progressively in those who died, but the cholesterol returned to normal in those who recovered.

Okada (114) produced peritonitis by perforating the small intestine of dogs just above the appendix by means of a hot iron. He then studied the blood chemistry and found an increase of nitrogen, increased viscosity, a fall in the chlorides, delayed clotting time, and a delayed sedimentation rate. All of the animals died from

peritonitis, and in the exudate he found large amounts of histamine picrate. He produced similar symptoms in animals by the injection of histamine and concluded that histamine is probably the important factor in death from peritonitis.

B. Toxicity of the peritoneal exudate.

Harmon and Harkins (55, 56, 57) produced peritonitis in dogs by leaving an open ileal loop within the cavity. They then filtered the exudate and injected it into other animals, the injection producing a fall in the blood pressure. The same result was obtained with filtrates of bacillus-coli and clostridium-welchii cultures, as well as non-protein extracts of these filtrates.

Scott and Wangensteen (154) injected large quantities of peritoneal exudate, obtained from dogs with various kinds of strangulated loops of intestine. These exudates never caused a fall in the blood pressure unless there was a bacterial element within them.

Blalock (9) produced peritonitis by dividing the meso-appendix and opening the appendix in dogs. Some of his animals died quickly, some slowly, and some survived. In these animals he found that the subcutaneous administration of saline solution caused no increase in the peritoneal exudate, but the intravenous administration of this solution caused a marked increase of the peritoneal exudate with a lowering of the protein content of this fluid.

Bergh, Bowers, and Wangensteen (6) perforated the stomach in two series of dogs, one with, and one without, a full stomach. Of 29 dogs with an empty stomach, only 2 died. Of 30 dogs recently fed, 26 died. Of 17 dogs perforated immediately after the ingestion of fluid only 3 died. Of 16 dogs with a perforated duodenum 12 died, and of 9 dogs with a perforated jejunum 4 died. Of 9 dogs with a perforated lower ileum, all died. Of 7 dogs with a perforated cecum, 2 died. Of 8 dogs with a perforated rectum, 1 died. These findings confirm the observations of previous authors: that the lower ileum is the most infective part of the gastro-intestinal tract.

C. The reaction to inert substances.

Norris and Davison (109) found extensive foreign-body reaction in the peritoneum of 2 patients who had been operated upon previously and in whom liquid petrolatum had been instilled to prevent the formation of adhesions.

Several authors, including Owen (116), Miller and Sayers (99, 100), and McCord (92), have observed the reaction of the peritoneum to certain powders and dusts. McCord and his collaborators attempted to measure the harmfulness of various dusts in human lungs by their reaction in the peritoneal cavity of animals, considering those dusts which caused proliferation as the most harmful.

D. Bile-peritonitis.

A number of authors have concentrated their attention on clinical and experimental observations in bile-peritonitis. In their experimental work most of them produced peritonitis by the injection of bile or bile salts or by permitting bile from either the ducts or gall bladder to flow into the peritoneal cavity. All of these observers noted a resulting profuse exudation of fluid into the peritoneal cavity.

Harkins, Harmon, and Hudson (54, 54a) estimated the exudation to be approximately a third of the blood volume and 60 per cent of the plasma volume, with resultant marked hemoconcentration. They believe that death is due to this, rather than to the activity of bacteria which appear later.

Moon and Morgan (104) examined the inflamed tissues microscopically and found marked capillary and venous engorgement of the serous surfaces and mucosa of the gastro-intestinal tract, kidneys, and lungs. They concluded that bile caused an increased permeability of the capillary walls.

Weinberg and Levenson (195) have maintained the view hitherto held, that such intense irritation of the peritoneum favored the passage of bacteria through the walls, and they have recommended the use of appropriate sera.

Mentzer (98) in a review of 74 articles on the subject, to which he adds a series of his own, concludes that human mortality depends almost entirely on whether the bile is infected or not. In his series of 24 cases, in which there had been a perforation of the gall bladder, 4 patients not operated upon died, but 14 of 20 who were operated upon recovered. He believes that bile-peritonitis is much more dangerous in experimental animals than in man, because the bile of dogs contains more bile salts and bile acids than human bile and is much more apt to contain micro-organisms.

Trussler, Reeves, and Martin (183) have pointed out that the bile of dogs frequently contains an anaerobic bacillus, which closely resembles clostridium welchii, but does not produce toxin. They and a number of other authors have experimented extensively on animals and have injected liver, either fresh or old, incubated or autoclaved, into the peritoneal cavity, but these experiments do not seem to have any application to our knowledge of the disease as it occurs in man.

IV. BACTERIOLOGY

A number of authors have attempted bacteriological studies of the normal and inflamed peritoneal cavity, but most of them have not appreciated the difficulties encountered in such a study. For example, some have completely ignored the anaerobic bacteria and have not used the proper methods to reveal all of the bacteria which may be involved.

A. General.

Roberts, Johnson, and Bruckner (141) maintain that in the vast majority of cases the peritoneal cavity is not sterile. They obtained positive cultures in 76 per cent of their cases, in which the peritoneum was opened in clean operations. However, these organisms were practically the same as those which they obtained from the deep layers of the skin before the peritoneal cavity was opened, which would seem to indicate their source. They were chiefly diphtheroids and staphylococci. Many of these organisms they found also in the laboratory air. Perhaps the most surprising result of their studies was that their cultures from frank infections of the peritoneal cavity did not yield a very much higher per cent of positive results than cultures from the non-inflamed cavity. Their results do not conform to the usual findings.

Friedrich and Weber (44) confirmed previous observations in demonstrating many intestinal organisms in stomachs afflicted with carcinoma, while stomachs or duodenums with benign ulcers were shown to have very few organisms and the cultures were often sterile. With these findings they properly correlate the higher incidence of peritonitis following resection of the stomach for carcinoma as compared with gastro-enterostomy for ulcer. The relative magnitude of these procedures may likewise play a part.

Clavel (21) and his associates likewise confirmed previous reports of a higher mortality in cases of perforated gastroduodenal ulcer which yielded a positive culture at the time of operation than in those yielding no growth. Sterile cultures were obtained in a series of 10 patients and 1 died from pneumonia. Of 8 patients yielding positive cultures, 4 died, 3 with peritonitis. Only colon bacilli and streptococci were obtained from these cultures. No enterococci, staphylococci, or anaerobes were found.

Cazzamali (18) studied the bacterial flora in 81 cases of peritonitis, 64 of which followed appendicitis. The organisms in the order of their frequency were the colon bacilli, non-hemolytic streptococci, and clostridium welchii. In this respect he confirmed the work previously reported by Meleney, Harvey, and Jern (94). However, he disagreed with them in that he did not believe that a reliable prognosis could be made on the basis of these cultures.

B. Unusual cases.

Several authors have reported cases of acute peritonitis which yielded the enterococcus in pure culture. In Mondor's (102) series of 5 cases, all were characterized by a sudden onset, an abrupt rise in temperature, diarrhea, a large amount of peritoneal fluid, distention, and toxemia. All but 1 patient died.

Decoulx and Patoir (30) reported 8 similar cases, emphasizing diarrhea, usually preceded by eight to ten days of anorexia and malaise, as the outstanding symptom. All of the patients died.

Bertram and Bohne (7) presented 2 cases of acute diffuse peritonitis in which the infection seemed to arise in the upper small intestine, which was diffusely red and edematous or hemorrhagic. In both of these cases there had been a long period of anorexia and enteritis before the development of the classical signs of peritonitis.

Stefano (31) observed a case of an infant with pneumococcus peritonitis and pleurisy treated successfully by repeated aspiration and the injection of 15 per cent sodium taurocholate into both cavities.

Nagaoka (105) reported a fatal case which he considered primarily due to staphylococci. He was able to find only one similar case in the literature. The infection started with tonsillitis, and acute diffuse peritonitis followed. No focus was found. The appendix was normal. Staphylococci and a few streptococci were cultured from the pus, but were not more exactly classified, no colon bacilli or diplococci being present. The abdomen was drained and closed.

Cook (24) reported a case of peritonitis and one of tonsillitis in which the Friedlaender bacillus was grown from each, and he believed that the two disorders were associated. He makes no mention, however, of other organisms found in the cultures.

Gerlach (47) reports 2 cases of gas-bacillus infection, one peritoneal and the other pleural. Although the infected cavities showed no gas, the respective abdominal and thoracic walls did. These findings seem to confirm the idea that gas-bacillus infection seldom forms gas in serous cavities. On the other hand, Rhodes (137) reported 2 cases, in one of which gas was produced in the abdominal cavity and in the wall of the intestine. No culture was made in the first case; the clostridium welchii was found in the second. Rhodes makes no mention of other organisms, and it is not certain that they were pure Welch-

bacillus infections. Recently, however, the authors have observed a case of pure clostridium-welchii peritonitis with free gas in the peritoneal cavity without perforation of the gut.

Plath (124) divided cases of gas peritonitis into three groups. First are those with collections of gas in and around the peritoneal cavity without signs of peritonitis. Second are those with spontaneous gas formation in the inflammatory process. Third are those with gas coming from perforation of the gastro-intestinal tract.

Knobloch (86) reported the case of a girl with a blood agglutination titer of 1:1,000 for bacillus abortus. She developed a general peritoneal inflammation and was operated upon. A peculiar, thick, rather clear fibrinous exudate was found. The appendix was removed but showed only periappendicitis. Knobloch called attention to an earlier article by Simpson and Fraizer (161) who found epigastric pain in 16 per cent of their cases of bacillus-abortus infection. Three of these cases were operated on for appendicitis by mistake.

Kondo (87) reports an interesting case of peritonitis which developed without a sudden violent onset. At operation, a bloody seropurulent fluid filled the peritoneal cavity and the peritoneum was inflamed. There were large retroperitoneal nodes continuous with inguinal buboes. The fluid was injected into apes and guinea pigs and revealed the virus of lymphogranuloma inguinale.

These unusual cases are of interest in demonstrating organisms capable of producing peritonitis, but it should be remembered that the common organisms are the colon bacilli, non-hemolytic streptococci, and clostridium welchii.

C. Miscellaneous.

Meleney, Olpp, Harvey, and Jern (95) studied the synergy of the bacteria commonly found in peritoneal exudates. They showed that the minimal lethal dose of colon bacilli was less than that of the other two, and the virulence of colon bacilli could be enhanced by animal passage, but not that of clostridium welchii, or of the intestinal streptococci. Combinations of any two or all three of these organisms killed in very much smaller doses than pure cultures of any one of the three. The presence of the clostridium welchii did not indicate a graver prognosis than the others. These results seemed to indicate that the symbiosis or synergy of these organisms was important to their pathogenicity.

Biolato (8) starved a small series of guinea pigs for two or three days before an intraperitoneal inoculation with colon bacilli and found that they lived longer than another series allowed to eat normally till the time of inoculation. If the starvation was extended to eight days, however, the pigs showed less resistance.

Behrendt (5) was not able to produce peritonitis in animals by the intraperitoneal injection of bacteria unless his animals were in poor condition, and concluded that the localization of the infection might be due in part to this fact, at least in experimental animals.

David and Loring (28) attempted to produce peritonitis in dogs and rabbits by the injection into the peritoneal cavity of colon bacilli, streptococci, staphylococci, and pneumococci, along with their agar slants, or suspended in gum tragacanth. Most of the animals died rapidly of peritonitis. From the exudate not only the organisms injected but also Welch bacilli were uniformly cultivated.

V. CLINICAL ASPECTS

Many authors have reviewed the clinical aspects of peritonitis. One of the best reviews was by Flynn (39). He discussed the anatomical and physiological facts concerning the peritoneum, and the absorption of fluids and particulate matter. He divided peritonitis into the aseptic and infective types, the aseptic being due to mechanical injury or irritation by chemicals, blood, bile, urine, and digestive juices. This type usually subsides without serious consequences unless organisms are present in these fluids and an infective peritonitis follows. The infective type is comprised of primary and secondary infections. In the primary infections due to the pneumococcus and hemolytic streptococcus, the mortality is about 80 per cent if untreated, and slightly lower if operation is performed. The secondary infections are usually due to gastro-intestinal diseases with a passage of bacteria either through a perforation or through the compromised wall of the intestine. The organism most commonly found is the colon bacillus. Inflammation of the peritoneum is always accompanied by two important processes, (1), the production of an exudate, and, (2) a paralysis of the intestinal muscle, both of which limit the spread of infection. Flynn reviewed the well known symptoms and discussed the differential diagnosis. Prognosis depends principally upon the cause. When the peritonitis is due to perforation of the gut, prognosis depends upon the promptness with which that lesion is repaired.

A number of authors have considered the problem particularly from the standpoint of acute appendicitis. Most of these in general agree with the summary of Flynn given above.

Heyd (68) quoting Orr (115) states that the body can lose 40 per cent of its weight in fat, carbohydrate, and protein without death, but that the rapid loss of 10 per cent water is serious, and if it reaches from 20 to 22 per cent, it causes death. This must always be borne in mind in cases of peritonitis.

Bower (12) has continued his study of the mortality of acute appendicitis in the Philadelphia hospitals and has found some improvement as the result of his campaign for early operation and the avoidance of laxatives. He finds, however, that delay and laxatives are still the most important factors in the maintained high mortality.

Foss (40) found that the average duration of time between the onset of symptoms and the call of the doctor was seventy-four hours and the average time before admission, ninety-five hours. Only 7 per cent of the patients came in the hospital in the first twenty-four hours and 30 per cent in the first forty-eight hours. Those who died averaged four and a half days before surgical consultation and lived for an average of seven days after operation. Thus, the responsibility for the chief delay rests largely on the patients, but the doctor is at fault in permitting patients to go twenty-four hours more before sending them to the hospital. These twenty-four hours may be more important than the first forty-eight hours. In Foss' own series of 1,000 cases, the second 500 did not come into the hospital any earlier than the first 500 and the mortality was almost the same.

Schullinger (152) has recently reviewed the subject of acute appendicitis over a period of seventeen years at the Presbyterian Hospital in New York City. There were 2,653 cases of acute appendicitis with a total mortality of 5.8 per cent. One thousand, one hundred and seventy-five were cases of simple acute appendicitis with a mortality of .59 per cent. Six hundred and thirty cases of acute appendicitis with acute localized peritonitis showed a death rate of 1.9 per cent. Five hundred and seventy-one cases with abscess showed a mortality of 10.5 per cent. Among 329 cases of acute appendicitis with acute diffuse peritonitis, the fatal cases amounted to 17.02 per cent. Of 25 patients with acute appendicitis with acute general fibrinopurulent peritonitis, 88 per cent died. The mortality when judged in five-year periods during these years remained unchanged.

Over approximately the same period, McClure and Altemeier (91) reported a total death rate of 10.4 per cent, but found that their mortality figures when considered over five-year periods showed a steady decline. They studied the bacteriology of the peritoneal exudation and found the colon bacillus to be by far the most frequent organism, occurring in 77 per cent of the cases, and the non-hemolytic streptococcus and the Welch bacillus next in order. They made no attempt to correlate the bacterial findings with the clinical course or mortality.

Giertz (48) has given a statistical review of cases of peritonitis in Sweden, with results which are similar to those reported in this country.

A number of authors have given particular attention to the study of postoperative peritonitis. Cutting (27) points out that postoperative peritonitis may be rapidly overwhelming or mild, and is difficult to diagnose. There is usually a latent period of from forty-eight to seventy-two hours, and pain may be minimal or absent. Intestinal activity stops and nausea and vomiting occur. Abdominal tenderness and rigidity are usually but not invariably present. Because of these facts and the difficulty of accurate diagnosis, the value of secondary operations is usually less than the value of primary operations for peritonitis, except when there has been a rupture of intestinal suture lines, massive hemorrhage, or bile leakage.

Stich (175) has reviewed 6,421 surgical cases over a period of ten years and found a 1.36 per cent mortality from peritonitis. The abdominoperineal operation for rectal carcinoma yielded the highest percentage of deaths from peritonitis (17 per cent). Following gastric resections for carcinoma 3.5 per cent of the patients died of peritonitis, 6.9 per cent dying after sleeve resections.

Shambaugh (158) found a mortality of 16 per cent from peritonitis among the fatalities which followed gastric surgery, 14 per cent following operations on the small bowel and 33 per cent following procedures on the large bowel. Some of the deaths attributed to pneumonia in his series may also have had the contributing factor of peritonitis.

VI. PROPHYLACTIC TREATMENT

A. Vaccines.

The most active workers in this field have been Steinberg and Goldblatt (170, 171, 172) some of whose articles antedate the period covered by this report. Working with dogs, Steinberg (164, 165, 166, 167) reported in 1931 that they had succeeded in protecting almost two-thirds of their dogs against peritonitis produced by the administration of from three to five minimal lethal doses of colon bacilli suspended in gum tragacanth. They achieved this protection by giving four doses of bacillus-coli vaccine on the four consecutive days before the organisms were in-

jected. Fewer preliminary doses gave less protection, as did a vaccine prepared from a mixture of organisms. When, however, they produced peritonitis by a mixture of organisms instead of by colon bacilli alone, they could demonstrate little protection from either their bacillus-coli vaccine or their mixed vaccine. On the basis of these experiments, they concluded that their bacillus-coli vaccine given in four successive daily injections was their best protecting agent. They thereupon gave it to human beings, injecting intraperitoneally four billion organisms in 50 c.cm. of saline solution, which had been divided into successive daily doses of 5, 10, 15, and 20 c.cm. No humoral antibodies were found either in the serum or in the peritoneal fluid after these injections, but it was shown that in dogs a great outpouring of polymorphonuclear leucocytes into the peritoneal cavity occurred after the protecting doses of vaccine had been given, and to these phagocytes the degree of protection obtained was attributed.

Later, Steinberg and Goldblatt (173) found that living colon bacilli suspended in a 1 per cent solution of gum tragacanth remained in the peritoneal cavity longer than when suspended in saline solution. They then conceived the idea of suspending their vaccine in gum tragacanth, and so evolved a protective emulsion which they called "bactragen." They attributed part of the virtue of this emulsion to the peculiar properties of the strain of colon bacillus which they used. With the emulsion of heat-killed bacillus-coli vaccine in gum tragacanth, they obtained better protection than they did with the same vaccine in saline solution or with gum tragacanth alone. With controls dying in all instances, they appeared to demonstrate protection against intraperitoneal injections of living colon bacilli suspended in gum tragacanth, against a mixture of pyocyaneous bacilli, streptococci fecalis, and clostridia welchii given intraperitoneally, and against peritonitis evoked by injury to the cecum of dogs.

Steinberg and Kobacker (174) protected dogs with bactragen, and then produced peritonitis in them and in unprotected controls. The protected dogs showed less drop in their blood pressure, less cardiac arrhythmia, slower pulse, as well as less evidence of myocardial damage than did the controls.

Following these experiments, preparations of bactragen were used in human beings, preliminary to operations on the intestine in which postoperative peritonitis was feared. In 1934, Goldblatt (50) reported that 400 human beings had received injections of bactragen at the hands of various surgeons, with only 3 deaths from postoperative peritonitis occurring in the series. At the same time, Jones (77) reported 2 deaths with bloody peritoneal fluid after using the injections, and said that he had thereafter avoided its use. In 1936, Steinberg (168) reported 391 cases in which bactragen had been used, without any instance of postoperative peritonitis, and Potter and Coller (126) from the University of Michigan Clinic reported 79 cases with 11 deaths, but only 1 attributable to peritonitis. More recently Coller and Ransom (23) have reported the use of bactragen without any harmful effect in 300 cases. With the belief that the desired reaction comes in three hours, in the later cases they introduced it at the time of operation, instead of by preliminary injection.

Concurrently and basing his work largely on experiments by Herrmann (66) in 1928, Bargen had developed a vaccine made from colon bacilli and streptococci which was used chiefly at the Mayo Clinic, where it was given as one of several pre-operative measures before resection of the intestine. Dixon and Bargen reported in 1935 that this vaccine had been used in 1,500 patients, and that since its introduction the mortality from postoperative peritonitis had dropped 66 per cent. Rankin and Bargen (134) previously published encouraging results in a smaller series, but subsequently Rankin (133) reported that he had abandoned this method because he found that he had further reduced his operative mortality in the last 130 patients by other pre-operative measures. His former vaccine series of cases numbered 527. This does not mean with certainty that vaccine would not have permitted him to reduce the mortality still further. Herrmann (67) in 1936 was still using vaccine with an impressive reduction in mortality.

It seems clear from the work cited that some protection can be obtained in laboratory animals against peritonitis produced experimentally. The mechanism of this protection has not been clearly demonstrated. Steinberg (169) has argued that, because polymorphonuclear leucocytes appear in the peritoneal fluid in response to the protective injection and can be shown to ingest bacteria, they are the probable agents of protection. He calls this protection "hyperleucocytic pre-immunity." Rebeck (135) found that bacillus-coli vaccine gave peritoneal protection when injected intraperitoneally or intrapleurally in rabbits but not when injected subcutaneously. The part played by macrophages, the reticulo-endothelial system, and the humoral elements has not been sufficiently studied.

In spite of the interesting experimental work which has been done in the field of protection against peritonitis by vaccines, we do not believe that the extent of its value has been proved or disproved either experimentally or clinically. So many essential factors are to be considered including the type of vaccine employed, the dosage, the time and frequency of administration, and the manner in which the peritonitis is produced, that conclusive proof of any thesis is most difficult to obtain. It is not enough to say that one substance has protected better than another in two different series of animals in the dosages given. All practical dosages for each substance must be given in what has proved to be the best manner for each substance. In this respect, the experiments on bactragen are lacking. From the clinical side, any claim of lowered mortality due to any means must rest upon an adequate control series in which the means is not used. Such a series has not yet been reported. The use of vaccine holds promise, but should be placed on a more thorough experimental basis. In peritonitis we are dealing with organisms of low pathogenicity operating in an extensive cavity under variable physical conditions, and it is almost impossible to get two strictly parallel series of cases to compare.

B. Amniotic fluid (amfetin).

Bovine amniotic fluid, which has been concentrated, has been recommended as a preventive of both postoperative adhesions and peritonitis when given intraperitoneally. These two claims seem hardly compatible, as adhesions are one of the chief sources of defense against the spread of peritonitis. It has been used clinically as a preventive of peritonitis by Johnson (73, 74, 75) and by Young and Marks, (196) with apparent success. The series reported is hardly large enough to permit definite conclusions. Johnson also attempted to demonstrate its effect on dogs, and stated that it made them less sick than did vaccine, and that it produced a similar outflow of polymorphonuclear leucocytes and, later, of macrophages in the peritoneal fluid.

Kimpton (83) and later Gepfert (46) described the beneficial effects which they saw from the use of amniotic-fluid concentrate as a preventive of adhesions. The latter reported that in dogs the postoperative adhesions were as numerous but less dense if amfetin were used at the time of operation. His clinical cases seemed to have a smoother postoperative course if it were used. He warns against its use in the presence of pus.

C. Filtrates or antivirus.

Work with antivirus has been based on Besredka's conceptions. Klein (85) recovered a strain of the bacillus coli from the peritoneal cavity of a guinea pig in which peritonitis had been produced by ligation of a mesenteric vessel. From this strain he produced an antivirus which he injected intraperitoneally into other guinea pigs to test its potency to protect against homologous organisms subsequently injected. He demonstrated some protection, but no more than he could obtain with antivirus prepared from staphylococci or other organisms. He could show no protection in guinea pigs and rabbits if the antivirus was given after the organisms, or after the production of peritonitis. The use of coli antivirus in a few human beings showed no convincing evidence of benefit.

Montilli (103), working with filtrates to protect the peritoneum against homologous organisms and fecal soiling, obtained some degree of protection but this was never more than 20 minimal lethal doses.

Trinchera (182) demonstrated neither toxicity nor protection with filtrates.

Redi (136), in a few human cases of appendicitis with peritonitis, believed that he had seen benefit from the use of filtrate and anti-streptococcus serum.

Shimizu (159) used coli antivirus in similar cases and believed it efficacious.

Oka (113) found that heated antivirus was less toxic than the unheated, and evoked a more rapid leucocytosis and phagocytosis in the peritoneal fluid of guinea pigs, a reaction which was non-specific.

Ruggieri (143) observed that the intraperitoneal injection of staphylococcus antivirus protected against subsequent lethal doses of homologous organisms, unless trypan blue were injected after the antivirus, in which case there was no protection demonstrable. He believed that this was due to an alteration of the reticulo-endothelial system by the trypan blue, and argued that the protection, therefore, resided in the reticulo-endothelial system.

Reading the above reports together, it seems true that some protection against organisms injected into the peritoneal cavity can be evoked by the previous injection of filtrate or antivirus, but this effect may be due to non-specific irritation of the peritoneum. None of the investigators has conducted experiments of sufficient scope to throw much light on the matter, nor has any of them controlled his experiments by a study of the possible effect of bacteriophage, which may be present in any unheated filtrate. No convincing evidence appears in these reports that the use of antivirus clinically is justified.

D. Bacteriophage.

In animals, Rice (138) found that a mixture of streptococcus, staphylococcus, and coli bacteriophages gave no protection against peritonitis produced by feces or injury to the intestine in dogs. In mice, Jern, Harvey, and Meleney (72) obtained protection with intraperitoneal injections of bacillus-coli bacteriophage against bacillus-coli peritonitis, amounting to 25 times the dose of organisms that killed controls. This protection could be obtained not only if the bacteriophage was injected before the bacteria, but also when injected at the same time or up to three and a half hours afterward. Control animals usually died in five hours. Bacillus-coli filtrate did not similarly save the animals. Bacteriophage given subcutaneously had no effect if given after the organisms were injected. From the peritoneal cavities of mice that had been protected by intraperitoneal injections of bacteriophage, it could be recovered for several days afterward.

The evidence that bacteriophage can be used in the therapy of peritonitis, judging from the above reports, is slight but encouraging. It is possible that it may be useful in prevention, but only in cases in which the predominating organisms happen to be susceptible to the bacteriophage injected. There is little or no evidence that commercial preparations of single or combined bacteriophages have proved their value in the prevention or cure of peritonitis.

E. Miscellaneous.

Tabanelli (178, 179) obtained slight protection against colon bacilli by injecting colloidal silver and other chemicals intraperitoneally into guinea pigs. Siciliani (160) found little protection from 10 per cent sodium nucleinate or 10 per cent glucose.

Seeley (155) suggested treating antigens with sodium ricinoleate to lessen their toxicity, but reported no experimental work of his own in support. Schattenberg and Harris (146) failed to demonstrate any protection against pneumococci by the use of various vaccines. Shakudo (157) stated that he obtained slight protection against the bacillus coli by the oral administration of coli vaccine and grape sugar, more than from vaccine alone. None of this work suggests that non-specific substances can give significant degrees of protection against peritonitis.

Smith (162), working with rabbits, found that he could protect them against peritonitis due to a strain of hemolytic streptococci by a previous injection of a commercial preparation of streptococcus antitoxin globulins. There was little protection if the antitoxin was given after injection of the organisms. Diphtheria antitoxin failed to give protection, which is evidence that the protection was, in part at least, specific.

Carneiro (17), hoping that the natural immunity thought to reside in the peritoneum could be transmitted, made extracts of peritoneal tissue and injected them into 30 human beings with various infections of staphylococcus origin. He noted some alterations in the recipients' white cells, and believed that all the recipients but one had benefited from the treatment.

Rademaker (132) injected defibrinated sheep's blood into the peritoneal cavity of guinea pigs together with living colon bacilli. He found that the presence of the blood did not add to the virulence of the organisms.

VII. ACTIVE TREATMENT

A. Operative treatment.

Most authors believe in prompt operation in most cases of peritonitis, with removal of the focus of infection with a minimum of trauma. In the case of appendicitis, some surgeons, for example Foss (40), recommend that the appendix should always be removed, while others advise not removing it in the case of abscess or general peritonitis if it cannot be excised without the danger of spreading the infection. On the other hand, Kennedy (82) considers it important to remove the source of infection and break down adhesions "in order to relieve bowel obstruction and drain distant abscesses." He believes that operation should be done in cases of appendicitis within an hour after the patient is seen, and that "the watchful waiting of the physiological surgeon for a quiescent stage in the peritonitis abdomen due to a perforated appendix has been a disastrous blunder."

McClure and Altemeier (91) found that the lowest mortality in appendicitis occurred in the cases operated on through a McBurney's incision, and that spinal anesthesia was accompanied by a lower death rate than ether. Fairchild (37), likewise, draws particular attention to the use of McBurney's incision and spinal anesthesia instead of the right-rectus incision and general anesthesia. He estimated that his mortality was cut down one-third by these procedures alone, although his two series were not run in parallel. Flynn (62), likewise, prefers local anesthesia.

Jones (76) reported a series of cases of perforated appendix with diffuse peritonitis with a mortality of only 1.4 per cent, and explained his good results as being due to a cecostomy through the appendix stump. He used the cecostomy tube for the drainage of the cecum and for the instilla-

tion of saline solution, and in no case was there a prolonged fecal fistula.

There is a difference of opinion with regard to drainage. Kennedy (82) drains most cases and uses a coffer dam instead of tubes. Flynn (39) drains only when there is a localized abscess. Foss (40) believes that any drain is a dangerous procedure. Molnar (101) tried to settle the question of drainage by studying the exudate in cases of peritonitis following appendicitis. He stained the cells with Seyderhelm's supravital stain and based the criterion of drainage on the number of living as against the number of injured pus cells. Irrespective of the character of the pus or the number or nature of the contained bacteria, he suggested drainage when the number of injured cells exceeded 50 per cent.

Buchbinder (14, 15) and his co-workers tried to bring light to bear upon the question of drainage by an interesting series of experiments on dogs. They produced peritonitis by making an open loop of lower ileum, 40 cm. in length, and reestablishing the continuity of the bowel by end-to-end anastomosis. Usually it took about twenty-four hours of contamination from such a loop to produce a serious spreading peritonitis. Generally only the central half of the peritoneum became involved, while the pelvis and diaphragm remained free. Of 42 animals so operated on, 9 died from a leaky anastomosis. Of the other 33, 14 survived and 19 died. Five of the deaths were due to abscess and 14 to general peritonitis. No drains were used in this series, but in a second series of 20 cases in which the same procedure was used, 2 drains were placed in each case, and all of these dogs died. In 5 other animals the lower ileum was perforated and drains were applied in 4 of them. All of these dogs died. Buchbinder concluded from these experiments that in a spreading peritonitis the focus should be removed, the exudate should be sucked out, and the peritoneum should be closed. Drainage of the abdominal wall is advisable, but drainage of the abdominal cavity should be avoided.

B. General treatment.

McClure and Altemeier (91), Heyd (68), and others have urged the pre-operative administration of fluids. Most authors have stressed the importance of giving nothing by mouth after operation but restoring the water and electrolytes by parenteral administration. A few favor frequent transfusions of blood. Fowler's position is generally accepted and gastric suction through a nasal tube is rapidly gaining favor. Morphine is advocated by most authors. Flynn (39) believes that pituitrin and physostigmine are to be avoided, but Potter (127) reported a small series of cases in which he emphasized the importance of ileus and methods directed toward its control. Over a ten-year period he found a mortality of 35 per cent in acute diffuse peritonitis following appendicitis. About 75 per cent of these fatal cases presented ileus as a major factor. In the last 25 cases the mortality was only 12 per cent and there was no death resulting from ileus. Potter considered that 1 c.cm. of pitressin given every two to four hours after operation was of considerable value in preventing postoperative ileus.

Opinions with regard to conservative treatment for peritonitis as contrasted with prompt operative treatment still differ radically, but there is some indication that the conditions to which these treatments should be applied are becoming more clarified. Alton Ochsner (112) supports the conservative treatment advocated by his uncle, A. J. Ochsner. He points out that not the time in hours, but the condition of the patient when first seen, is the important factor. Operation should not be done if the bacteriological process is in the stage of localizing. Some cases should be operated on immediately on admission even if it is four or five days after onset of the symptoms, while others should be treated conservatively if they appear to be localizing within twelve hours of onset. Ochsner points out that conservative treatment requires constant supervision and careful surgical judgment. The principles are: to limit the spread and favor localization; to put the gastro-intestinal tract at rest by giving nothing by mouth; and to aspirate the stomach and duodenum. Fluids should be given by rectum, vein, or clysis. Fowler's position should be used for gravity drainage. Morphine acts not only as a general sedative but as a tonic to the bowel. Oxygen should be given if respirations are depressed. The questions that come to mind in considering this problem are: (1) How can the surgeon or the general practitioner tell whether the process is advancing or localizing? (2) How can he be sure that the measures employed will limit the spread and favor localization?

Coller and Potter (22) present the very low death rate of 9.3 per cent in cases of ruptured appendix with spreading peritonitis. These cases were treated by the Ochsner method. In the discussion of Coller's paper, Guerry reported 94 gangrenous ruptured appendices with diffuse peritonitis which were operated on immediately and carried a mortality of 10.64 per cent. In 135 similar cases treated by the Ochsner method there was a death rate of only 1.4 per cent.

Davis (29) went over his cases of death following appendicitis with the express purpose of attempting to determine whether or not conservative therapy would have modified his mortality, and concluded that his death rate could have been lowered not over 1 per cent by this means. He believes that he would have lost a number of cases which he thinks were saved by operation. He prefers limiting conservative treatment to fulminating cases if any. Cutting (27) believes that Ochsner's method of treatment is usually much better for postoperative peritonitis than operative treatment, with morphine, Fowler's position, frequent gastric lavage or continuous gastric suction, nothing by mouth, and parenteral fluids, from 4 to 5 liters a day. When the acute stage is passed, residual abscesses should be sought, but they should not be approached surgically until they have become well localized. Pelvic abscesses frequently may be opened through the rectum. Lumbar abscesses are usually easy of approach, while subphrenic collections are usually the most difficult. Cutting emphasizes the importance of x-rays in the diagnosis of subphrenic abscess and believes that operation should not be unduly delayed when diagnosis has been made.

In general it may be stated that we have come to a better understanding of the profound physiological disturbances that go on in the presence of peritonitis. The fundamental requirements are (1) the re-establishment of a normal fluid and electrolyte balance before or as soon after operation as possible; (2) the removal of the distributing focus of bacterial propagation, and (3) the restoration of the peristaltic function of the gastro-intestinal tract.

C. Serum.

Over 50 articles have appeared in the medical literature concerning the treatment of peritonitis with various sera. Almost all of these reports are concerned with the clinical results in human cases. Very little is presented in the way of experimental work. It is impossible to tabulate these articles, and, for several reasons, difficult to attempt even to evaluate them. Most of the writers obviously are not discussing comparable series. Some of the sera have been given prophylactically, while some have been employed only curatively, and the indications for use in each instance have varied. Various kinds of sera have been used; they have been prepared by several different laboratories and against differing organisms or their products, and administered singly or in combination, in ranging doses, and by different routes.

The sera used have been obtained from horses as a rule, but in at least one instance cattle have been employed to avoid reactions which might occur in patients sensitized to horse serum. The following antigens have been employed: (1) bacillus-coli filtrate, (2) the toxins of clostridium welchii or of combined anaerobes, (3) a combination of the two just cited, (4) enterococci, usually added to colon bacilli and the anaerobes, (5) bacterial bodies as well as toxins of colon bacilli together with the anaerobes, (6) a number of other organisms such as the bacillus fusiformis, bacillus fundiliformis, staphylococcus, and intestinal streptococcus, which have produced a serum to which is added polyvalent anti-gas-gangrene serum and anti-coli serum.

There is rationale for the use of at least some of these antigens in the attempt to develop a serum for use in peritonitis. Many investigators have reported that the organisms commonly found in the intestinal tract are present in the peritoneal cavity in large numbers in most cases of acute diffuse peritonitis following intestinal lesions. Of these, the bacillus coli is most commonly found, with clostridium welchii and the intestinal non-hemolytic streptococcus next in order of incidence and probable significance. At least two of these, the bacillus coli and clostridium welchii, can produce toxins. It is reasonable to suppose that these organisms or their products add to the morbidity in peritonitis, and that potent antisera against them would form a valuable therapeutic aid. However, it is not clear, except in the case of the anaerobes, that such potent sera can be produced commercially. It is also not known that a serum produced against one strain of bacillus coli, for example, will be effective against other strains. In work shortly to be reported, we have tested in mice one of the German-made commercial bacillus-coli antisera that has been used clinically abroad against a strain of relatively virulent colon bacilli, and we could show no protection from it. In collaboration with one of the commercial firms in this country, we, earlier, attempted to produce in horses a potent bacillus-coli antiserum, but with little success. We did develop, however, in the laboratory, a serum in rabbits which protected mice against many lethal doses of the homologous bacillus coli if given before the organisms were injected.

The first use of bacillus-coli serum clinically has been attributed to Guthrie (53), but he used serum together with coli vaccine only in cases which underwent no operation, and in which the diagnosis was doubtful. Weinberg (192) and later, Katzenstein (80), in 1927, appear to be the chief instigators of the present effort at sero-

therapy for peritonitis. The sera have been given intraperitoneally at the time of operation, subcutaneously, intramuscularly, intravenously, and, by Matyas (90), directly into the subperitoneal tissues and site of incision into the abdominal wall. The dosage has varied from about 50 c.cm. to more than 300 c.cm. given the day of operation and on subsequent days. Frequently it has been given intravenously while the patient was under anesthesia, for there is evidence that anaphylactic reactions may thus be avoided. Serum reactions have been frequent, usually not serious, but apparently leading to death in one or two instances of the 2,500 or more cases in which serum has been used.

In view of the heterogeneous nature of the reports, it must be admitted that the value of serum in the treatment of peritonitis is not yet proved, although it is significant, we believe, that the reports favoring its use outnumber the adverse reports by almost six to one. Most of the surgeons who favor its use present statistics to show that since the introduction of serum their mortality from peritonitis has fallen. Coming from one or two clinics, statistics of this sort might not be impressive, but coming as these do from many reputable sources, it is impossible to ignore them. Men who have reported a drop in mortality rate observed in their own clinics since the introduction of serum include Banfi, Canavero (16), and Pellegrini (119, 120, 121) in Italy; Dick (33), Gundel and Suessbrich (52), Kunz, Krenn and Reichl (88), Nobel (108), Riemann (139), Spitzer (163), and Stoeger (176) in Germany, and Prochnow (130, 131) in Hungary. In France, Vincent (188, 189) favoring chiefly a bacillus-coli serum, and Weinberg (193, 194) favoring a complicated mixture, are enthusiastic. Priestley and McCormack (129) at the Mayo Clinic report a lowered mortality in a small group of cases. In the United States and England, the sera have apparently been little used.

The most convincing of the articles in favor of serum to our minds has been that of Riemann (139). He reports 368 cases of peritonitis in which either coli serum or a combined "peritonitis serum" was used during the period from 1931 to 1933. He saw no difference in results from the two types of sera. Of the 368 cases of peritonitis, 244 followed appendicitis with a 4.5 per cent mortality, and 124 followed other lesions with a 20.9 per cent mortality. In previous three-year periods without the use of serum the mortality had been from 21.7 per cent to 22.5 per cent for peritonitis following appendicitis and from 37.7 per cent to 38.4 per cent for peritonitis following other causes. The number of cases in each three-year period had been nearly constant, and the late cases had been always relatively few, as Riemann served an urban community. He was impressed by benefits of the serum which do not appear directly in the mortality statistics, such as the early return of peristalsis. He never used over 100 c.cm. of serum for a case. There is, on the other hand, the report of Kapel (78) who also used coli serum with or without anti-anaerobe serum in 330 cases of postappendicular peritonitis, selected his sickest patients, and saw no benefit with regard to the mortality either in comparison with his earlier results without serum or with the results in neighboring clinics.

In addition to the above reports, there have been others which tell of the use of sera with varying degrees of enthusiasm. The authors include Aievoli (1), Balogh (3), Gohrbandt (49), Iacobovici (69), Katzenstein and Zimmer (81), Matyas (90), Nossen (110), Perrando (122), Pozzi (128), Schmiedt (149), Schneider (150, 151), Schulze (153), Klages (84), Trifkovic (181), Van Heerde (186), Verner (187), and Zukschwerdt (197). Mentioned in almost all reports are the surgeons' impressions of the unexpectedly smooth course of the serum-treated patients, the early return of bowel function, and lack of postoperative complications. Six men, Borchard (11), Kapel (78), Santi (144), Schmechel (148), Urech (185), and Vorschuetz (190), have run counter to the general trend, and stated that they have seen no benefit from serum. Two of these, Kapel (78) (Copenhagen) and Urech (185) (Switzerland), have formed their opinions only after a fairly extensive clinical trial. Santi (144) in Italy has had the interesting opportunity to try a serum in 14 cases in which, for one reason or another, operation was not attempted. Nine of the 14 patients died. It is not fair to say from this that serum may not be a useful adjunct to operation.

Very meager experimental work has been reported by Perrando (122), Geller (45), and Chiari and Kunz (19), each of whom tested the effect of sera given to guinea pigs or rabbits, which also received anaerobes or feces intraperitoneally. They all demonstrated some protection, but their series of animals were small.

In summary, concerning the serum therapy of peritonitis, we may say that while it is difficult to evaluate the reports of its clinical use, they are encouraging, and the subject deserves to be investigated further experimentally. Before the sera are employed clinically, they should be proved to be effective in animals against the organisms that they are designed to combat.

D. Bacteriophage.

Bacteriophage obtained from the bacillus coli has been used by Jacobs (71), Freedman (41), and by Ruddell, Sicks, and Loomis (142) in human cases of peritonitis. It is not possible to say from the reports what benefit was derived. Blanco (10) states that he has obtained good results from it. Tsouloukidzé (184) gives an interesting report of 47 cases of intestinal perforation occurring in patients with typhoid fever. Of these, 27 were treated by operation without bacteriophage with a mortality of 89 per cent. The other 20 received operation plus a mixture of bacteriophages and presented a mortality of 35 per cent, a striking drop even in so small a series. The reports on the whole are encouraging, but convincing evidence awaits a large series of cases with a lowered mortality and a shortened period of convalescence, in which a potent bacteriophage has been used against susceptible organisms.

E. Ultraviolet light.

A great deal of interest has been aroused by the report of Hans Havlicek (61, 62, 63), who in 1932 reported the treatment of 108 cases of peritonitis following appendicitis without a single death. He referred to a review of peritonitis by Kirschner, which revealed a mortality of 47.7 per cent in 11,000 cases, and of 38.5 per cent, in the cases resulting from appendicitis alone. Havlicek uses the "Laparophoslampe" with a Wood's filter which gives essentially a monochromatic light permitting line 366 to come through. This light is luminescent, and the visible rays and those which produce erythema and conjunctivitis are filtered out. The lamp hangs from the ceiling and can be directed on the operative field without interfering with the main source of luminous light or with the sterile technique. In cases of peritonitis following appendicitis the appendix is removed first. The cecum is then replaced in the peritoneal cavity and a loop of the lower ileum is delivered. When possible the omentum is also brought out. Then, by the raising of the operating table and lowering of the lamp to within 35 cm. of the exposed loop, the intestine, mesentery, and the omentum are exposed, first on one side and then on the other, to the beams of the light. The duration of exposure is not constant. In mild cases five minutes seemed to be enough. In severe cases ten minutes, and when the prognosis would ordinarily be extremely bad, these tissues were occasionally exposed for twenty-five minutes. In a number of the severe cases also other portions of the intestine, including the transverse colon were brought out. After exposure, the loops were restored to the peritoneal cavity and the abdomen was always closed without drainage, although in badly infected cases the abdominal wall was usually drained for from three to four days. Havlicek emphasized the importance of using local anesthesia. He let all but the very sick patients get up from the operating table and walk to their rooms, with no apparent bad results. He was impressed also by the absence of pain in the postoperative course. Furthermore, he never found in any of these cases any complications such as residual abscesses in the pelvis, the subphrenic space, or the liver, or, in any instance, pneumonia, embolism, thrombosis, or other complication.

What the method of action of the ultraviolet light is, Havlicek cannot say for certain, but various experiments on the placental circulation seem to indicate that the ultraviolet light penetrates through the blood-vessel walls and acts upon the blood itself. This blood, mixing with the blood coming from the rest of the intestine and the spleen, enters the liver. Ellinger, of the Fredericks Institute, believes that histamine is formed by the action of the ultraviolet light on histidine, and that the histamine thus formed in some way restores the splanchnic circulation to normal. He believes that the ultraviolet light may also act upon the endothelial cells and stimulate the production of opsonin or complement, and thus increase the immune substances.

In later articles, Havlicek (64, 65) presents further experiments concerning the effect of the ultraviolet light and claims to have demonstrated that the arterial system is connected with the venous system, not only by the regular capillaries, but also by blood vessels which are opened or shut by authority cells, "Quellzellen." These cells are activated by substances normally present in the body and by certain drugs. He believes that the ultraviolet light releases or forms certain products in the mesentery and omentum which open these special arteriovenous connections. This speeds up the whole splanchnic circulation and thus overcomes the venous stasis which is one of the chief causes of thrombus formation. He believes that morphine and products of the posterior lobe of the pituitary gland act to close these capillaries and are thus contra-indicated postoperatively. The capillaries are also blocked under chloroform or ether anesthesia. The rapid flow of the portal blood enables it to become rapidly detoxified.

A number of authors have tried to confirm Havlicek's results. Three of their articles give unqualified confirmation. Although they did not have his perfect score, the authors were much impressed by the favorable results.

Breitner (13) used the same technique on a series of 29 patients, 10 of whom had typical bacterial purulent peritonitis. Two of these died, one a child practically moribund on admission. Eight of the 10 patients had a perforation of the appendix with foul pus in the peritoneum, and were very sick. In 1 of the other patients, there was a gangrenous appendix about to perforate, and in the other an acute appendicitis with purulent exudate free in the peritoneum. The bacterial flora in these cases was not determined.

Breitner quotes from Eppinger, who has shown that in cases of peritonitis there is a capillary stasis caused by the bacterial toxins. This results in a puddling of blood in the splanchnic area and a deficient return flow of blood to the heart. There is a corresponding decrease of the minute volume of the cardiac output. He believes that the histamine which is probably produced through the irradiation of the intestinal loops by the ultraviolet light, opens up the arteriovenous anastomoses. The pressure in the portal vein rises, as does the minute volume of the cardiac output.

Nicole (107) used Havlicek's technique in 44 cases of peritonitis of which 8 were due to perforated ulcer, 14 to perforated appendices, and 22 to acute appendices. All the patients recovered, except 2 with perforated ulcer. He was impressed by the favorable postoperative course and the shorter stay in the hospital, and although there were many complications, none was very serious.

Paschoud (118) reported a number of cases in which he used the ultraviolet light as recommended by Havlicek. His series included 1 case of hemolytic streptococcus peritonitis in which the appendix was removed, the stomach and the small and large gut were punctured in five places to let out the gas, and ultraviolet light was applied to a coil of ileum. The operation was done under local anesthesia. The patient got up from the operating table, walked to the elevator, and that evening walked around the room, and promptly made an uneventful recovery. Paschoud also had 2 cases of appendiceal abscess which he operated upon and closed without drainage. When he operated later to remove the appendices he was surprised to find no adhesions. Everything appeared normal, including the appendices. He agreed with the explanation given by Havlicek, that in some way or other the stagnation of blood in the splanchnic area was prevented.

Nowotny (111) likewise reported the use of ultraviolet light. He treated 62 cases according to Havlicek's technique, except that he drained, used general anesthesia at times, and did not allow the patients to get up from the operating table as Havlicek did. He also gave alkaloids if necessary. He was not able to show any lowering of the mortality of the treated cases as compared with the untreated group, but at post mortem in his fatalities there was usually evidence of diminished or absent peritonitis. This would seem to indicate the importance of following Havlicek's technique in strict detail.

On the other hand, the experience of Clairmont (20) did not bear out the claims of Havlicek. He does not say how many cases he treated nor does he give the details of his technique. He did not see any striking improvement in the postoperative course, and his patients developed residual abscesses and emboli. He believes that his experience neither confirmed nor refuted the experience of Havlicek and suggested further scientific study of the problem.

Domanig (36) used the lamp in 197 cases, some clean and some infected, withholding it in the same number to establish controls. He saw no benefit of any kind from the lamp.

Friedrich (43) made some experimental studies on the effect of ultraviolet light in animals. In normal animals in which the stomach or intestinal loops were eventrated, he demonstrated the widening of blood vessels, especially the veins, thus slowing the circulation. In the treated animals, this effect was much diminished after two minutes or more of exposure to the ultraviolet light. He also found that when indigo carmine was given intraperitoneally it was absorbed much better in the animals treated with ultraviolet light than in the untreated, as judged by the amount excreted in the urine. After irradiation of the entire small intestine of his animals, they developed enormous appetites.

These results of Havlicek are astonishing and if they can be confirmed are truly significant. Clinical data can be obtained only by a large series of cases in the hands of a number of careful observers. It would seem that the theories with regard to the mode of action of this narrow band of ultraviolet light would lend themselves to experimental proof, and it is hoped that Havlicek and others will carry on their investigations in this field.

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SURGERY OF THE ABDOMEN

ABDOMINAL WALL AND PERITONEUM

Hertel, E.: Lymphadenitis Mesenterialia (Lymphadenitis mesenterialis). *Beitr. z. klin. Chir.*, 1937, 166: 231.

The mesenteric glands present all kinds of unspecific inflammations, from the simple hyperplasia of the sinus catarrh to purulent fusion and purulent perforation peritonitis. In first place stands the lymphangitis of the appendix, which is not essentially very different from lymphangitis mesenterialis, and which is frequently confused with pseudappendicitis with negative histological symptoms. The author states that a true diagnosis could be obtained if the vermiform process bed were subjected to a searching examination. Because of the fact that macroscopic changes at the outlet of the organ are usually absent, it is to be assumed that lymphadenitis is caused mainly by the action of swallowed bacteria which reach the glands through the intestinal wall and there produce an allergic inflammatory condition.

The most prominent clinical symptoms are the peritoneal irritations of different intensity according to the seat and degree of the glandular infection; only the simple hyperplasia produced no peritoneal symptoms. The abdominal symptoms are not as distinct as in appendicitis; the pain may center also in the left side. In the simple cases, there is an absence of the board-like hardness of the abdominal muscles, Blumberg pain, pain in the ileocecal region or the Rovsing symptom, resistance, and vomiting. There remains only the deep palpation pain centering about the navel. In the disease of the mesentery proper, there is a feeling of pressure, a sense of repletion, and pain in the region of the stomach. In the more serious cases, there is a high temperature, from 38 to 39 degrees, and a high leucocyte count (20,000) in contrast to the relatively insignificant local symptoms. The condition resembles influenza or infectious gastro-intestinal diseases. The differential diagnosis from appendicitis remains difficult, consequently, one should beware of postponing urgent action. In spite of the fact that the mesentery lymphadenitis appears always secondary, it presents itself with its clinical symptoms as an independent complete picture in which sometimes the source of infection is veiled or is often hard to locate. The name "lymphadenitis mesenterialis" has the same justification as "lymphadenitis colli" when after the reduction of laryngeal infection the inflammation of the cervical region is most prominent. Lymphadenitis mesenterialis is frequently the first concrete revelation of inflammation in the form of a mild or symptomless appendicitis, typhlitis, or enteritis. It is possible to develop cholecystitis or pancreas disease over the plexus celiacus through retrograde transport or propagated thrombolymphangitis in lymphadenitis mesenterialis of the vermiform region. There are relapses even when the source of infection is healed, so that, for example, it is possible that pain will remain after the removal of the chronically afflicted appendix.

In regard to the possibility of secondary independent disease, abscess and perforation or induration and adhesion, it is safe to accept Borchard's current stand that in ileocecal lymphadenitis the diseased regional glands should always be removed along with the appendix and never without it. It is noteworthy that after these steps have been taken the decline of fever takes place only gradually.

(Sievers). Clarence C. Reed, M.D.

Adams, W. E., and Olney, M. B.: Mesenteric Lymphadenitis and the Acute Abdomen. *Ann. Surg.*, 1938, 107: 359.

The authors give the case histories of 8 proved and 5 probable cases of mesenteric lymphadenitis simulating an acute lesion of the abdomen. Of these, there was only 1 case of tuberculous mesenteric adenitis. There was 1 death following operation.

Clinically, two of the most outstanding features of this condition are the colicky nature of the abdominal distress and the marked tendency toward recurrent attacks. There is often a history of a recent or concurrent upper respiratory infection. All of the authors' patients were between the ages of one year and fourteen years. The child aged one year died following operation. In the cases of one-half of the patients, the pain remained generalized over the abdomen and in only 2 was it localized in the right lower quadrant of the abdomen. Nausea and vomiting occurred in most cases, and diarrhea was present in 5.

The white-cell count is frequently elevated out of proportion to the patient's temperature. It was not uncommon to find a white-cell count of over 20,000, though only 4 of the patients had a temperature of 101.3 degrees.

A definite pre-operative diagnosis is difficult, if not impossible. The history of many previous attacks and the colicky nature of the abdominal pain, together with the lack, in many cases, of localizing signs or symptoms, are helpful in suggesting a definite diagnosis. Mesenteric lymphadenitis is almost always confused with acute appendicitis, and it must also be differentiated from pyelonephritis, intussusception, and Meckel's diverticulum.

Exploratory laparotomy is indicated in most cases in which the diagnosis is uncertain. In some cases it is possible to observe the patient for several hours before a definite type of treatment is chosen. The restoration of fluid and the mineral balance, and the limitation of intake by mouth to a minimum may be carried out while a decision to operate is being made.

A rapid subsidence of abdominal symptoms and pathological findings is very helpful in the determi-

nation of the true nature of the condition. The period of observation need not be longer than two or three hours, but if the symptoms and findings make delay seem hazardous, exploration should be carried out at once. The danger accompanying exploratory laparotomy and appendectomy is little compared to that associated with complications arising from a mistaken diagnosis. When exploration is undertaken, removal of the appendix is a routine procedure. Lymph nodes are removed only for diagnosis.

EARL O. LATIMER, M.D.

Irwin, F. G.: Acute Iliac Adenitis: A Report of 18 Cases. *Arch. Surg.*, 1938, 36: 561.

Acute iliac adenitis is not as uncommon as the lack of its recognition would indicate. It occurs in children and is characterized by a history of cutaneous infection on the lower extremity, and the appearance of a tender, fixed mass in the iliac fossa, accompanied by pain, fever, leucocytosis, and spasm of the psoas muscle. Irwin presents a review of the literature, reports a series of 18 cases, and gives a comprehensive description of this clinical entity.

The vagueness of the symptoms of acute iliac adenitis at the onset, and the resemblance of the symptoms to those of appendicitis, hip-joint disease, osteomyelitis of the head of the femur, and abscess of the psoas muscle account for the infrequency of correct diagnosis.

The disease is more common in boys than in girls, undoubtedly because trauma and infection are more common in boys. Pain in the iliac fossa, the lower part of the abdomen, or the groin, is the predominant symptom. A mass occupying the iliac fossa is always present, and can often be felt through the rectum.

Conservative treatment is recommended at first. Operative treatment consists of extraperitoneal approach to the mass, followed by incision and drainage. Irwin operated upon 10 of his 18 patients, all of whom recovered. Five were cured by conservative treatment and, because of a mistaken diagnosis, 3 were operated upon for acute appendicitis, but these also recovered.

EARL GARSIDE, M.D.

GASTRO-INTESTINAL TRACT

Maddock, W. G.: Nutritional Disturbances Associated with Diseases of the Stomach and Duodenum. *Am. J. Surg.*, 1938, 39:12.

The altered physiology and biochemistry associated with lesions of the stomach and duodenum are as important as the etiology, symptoms, pathology, and operative correction of the condition. Nutritional disturbances may cause vitamin, mineral, protein, carbohydrate, or fat deficiencies, either individually or in combination. Caloric requirements cannot always be met adequately, although the parenteral administration of glucose is a distinct aid in the prevention of ketosis. However, the substances that can be administered in quantities by the intravenous route, namely, water, glucose, and sodium chloride, are inadequate to maintain the health of the patient for more than two or three weeks. Vitamins and proteins are also needed and these requirements are often a considerable problem in the cases of patients who are seriously ill. Many of them have had a pre-operative period of malnutrition for months, and a long-standing deficiency is present. The purpose of this study is to review briefly the vitamin and protein deficiencies as they may affect the surgical patient with lesions of the stomach and duodenum.

Vitamin-A deficiency has been reported in patients with diarrhea secondary to gastrocolic fistula. Such a deficiency may be determined by the "keratinization test" of Blackfan and Wolbach, in which conjunctival scrapings show abnormal cornified epithelial cells. Carotene and fish oils meet this deficiency.

Vitamin-B deficiency occurs in patients with pyloric stenosis, gastric carcinoma, and polyps; it may occur secondarily in patients upon whom gastro-enterostomy has been performed, and may follow persistent vomiting after surgery on the biliary tract. It can readily be corrected by the administration of Vitamins B_1 and B_2.

The early signs of Vitamin-C deficiency may be determined from the urinary excretion, body store, and blood plasma, or from serum concentrations of cevitamic acid. A promising test consists in the production of venous stasis in an arm for fifteen minutes with a blood-pressure cuff at 50 mm. of mercury, and then the counting of the number of petechial hemorrhages in a skin area of 60 mm. in diameter in the antecubital fossa. The test is positive in the presence of more than 8 petechiæ; 5 or fewer constitute a negative reaction.

Vitamin-D deficiency may occur with celiac disease, sprue, external biliary fistula, and chronic jaundice. The value of viosterol in decreasing the hemorrhagic tendency in patients has been demonstrated by many investigators.

In the absence of gross bleeding, patients with gastric or duodenal ulcers usually show little change from the normal. On the other hand, patients with gastric carcinoma show a secondary anemia due to continual oozing from the carcinomatous surface. Pernicious anemias have followed partial resection for carcinoma, ulcer, and syphilis of the stomach, as well as gastro-enterostomy for peptic ulcer. The treatment varies with the type of anemia. The secondary anemias respond well to large doses of iron. For pernicious and other forms of hyperchromatic anemia large doses of liver are indicated.

The effects of protein deficiency are more frequently seen in surgical patients with malnutrition from disturbed gastro-intestinal function than in patients with malnutrition due to vitamin deficiencies. Prolonged low protein ingestion results in low plasma proteins, and nutritional edema is a rather common sequel. The edema may, however, be secondary to profuse surgical drainage, sepsis, loss of serum protein by massive hemorrhage, retention of base due to disturbed renal function, and

the administration of excessive amounts of water and salt. This water retention is of major significance because patients who are seriously ill and present malnutrition or sepsis have been shown to develop retention routinely if the water requirements supplied intravenously in the form of saline solution and sodium chloride were not needed. Jones and Eaton have shown that this retention may occur even when serum protein levels are approximately normal. Many investigators have shown clinically and experimentally that in the presence of low serum proteins the salt is essential for edema. The first thought of the surgeon, on finding edema in the sick surgical patient who has been receiving fluids parenterally, should be: "What are the serum protein values and how much sodium chloride has been given?" It is unnecessary and even harmful to the sick patient to administer more than a few grams of the sodium chloride daily when the plasma chlorides and carbon-dioxide combining power are normal, and when no abnormal loss of sodium chloride is occurring. Five per cent glucose in water may be used as it rarely produces edema.

As a prophylactic measure in patients with long-standing, severe malnutrition, several transfusions prior to the operation, and the passage of a Jutte tube down through the gastro-enterostomy stoma to the distal jejunum, during the operation, have been advised. This procedure permits nourishment early in the postoperative period. Eggs and milk may be utilized as a source of protein, and yeast and cod-liver oil will supply essential vitamins until the patient can tolerate solid foods.

SAMUEL J. FOGELSON, M.D.

Portnoy, B., and Wilkinson, J. F.: Vitamin-C Deficiency in Peptic Ulceration and Hematemesis. *Brit. M. J.*, 1938, 1: 554.

The authors present experimental evidence to support their belief that gastroduodenal ulceration is apt to occur in animals in a state of Vitamin-C deficiency. The importance of Vitamin C in the reproductive processes of animals has recently been emphasized, and a deficiency of this vitamin has been shown to be a potent factor in delayed wound healing. We now know that early "prescorbutic" or subclinical states of scurvy may occur quite frequently in patients who have received conservative dietetic treatment for peptic ulceration. The authors' study was based upon 107 subjects who were divided into 4 groups.

Group 1 consisted of 26 members of a departmental staff and medical students.

Group 2 consisted of 25 miscellaneous patients, excluding those with gastric or renal disease.

Group 3 included 25 patients who were suffering from proved peptic ulceration without hematemesis, and all patients on special diets of the Hurst No. 1 and No. 2 types.

Group 4 contained 31 patients who had been admitted to the hospital for severe hematemesis secondary to peptic ulceration. The diets of these patients had been very poor and they were put on special diets, usually the Hurst No. 1 type, on admission.

The methods of investigation for Vitamin-C deficiency included:

1. Determination of the daily urinary excretion of ascorbic acid.
2. The ascorbic-acid saturation test.
3. The plasma-ascorbic-acid determinations.
4. Oral ascorbic-acid tolerance tests.
5. Intravenous ascorbic-acid tolerance tests.
6. Intradermal tests.

Upon comparing the results of these methods and using the results to estimate the degree of saturation in normal subjects and in patients with peptic ulcer and hematemesis, the authors found that the daily urinary excretion of ascorbic acid is a fair index of Vitamin-C deficiency. A value of about 13 mgm. may be considered as being the average minimal excretion.

All patients in Groups 3 and 4 gave figures below 13 mgm. The saturation test for tissue Vitamin-C was found by these investigators to be more accurate than the estimation which was made of the total ascorbic acid excreted in the urine. However, unsaturation is not an abnormal state and this may occur in normal individuals unless they are on a diet which contains an excess of Vitamin C. Therefore a normal individual may rapidly become unsaturated. The intravenous ascorbic-acid tolerance test following the intravenous administration of 1,000 mgm. of ascorbic acid showed that normal individuals would excrete from 660 to 985 mgm. of ascorbic acid within twenty-four hours, while patients with peptic ulceration and hematemesis would excrete from 72 to 458 mgm. This conclusion may, however, not apply to patients with severe renal damage. The intradermal test of Vitamin-C deficiency gave results which agreed very closely with those obtained in the other tests, in that decolorization lasting longer than ten minutes indicated Vitamin-C deficiency.

All 6 methods showed that patients with peptic ulceration and hematemesis suffered from severe Vitamin-C deficiency. The most severe degrees of this deficiency were found in patients with hematemesis.

SAMUEL J. FOGELSON, M.D.

Bourne, G.: Vitamin-C Deficiency in Peptic Ulceration Estimated by a Capillary Resistance Test. *Brit. M. J.*, 1938, 1: 560.

Harris and his collaborators demonstrated that there was a low Vitamin-C output in the urine of 74 hospital patients with gastric or duodenal ulcer which were studied. This finding was confirmed by Archer and Graham, as well as by Troutt. The latter reports that half of a glass of orange juice caused no discomfort in most patients with peptic ulcer, and further points out that theoretically 40 liters of orange juice would be required to furnish the equivalent of the acid contained in 100 c.cm. of gastric juice at a pH of 1.7.

Svent-Györgyi discovered that the problem of the relation of Vitamin C to capillary fragility requires consideration of another factor called Vitamin P, which of course, is closely associated with Vitamin C and appears to be responsible for the condition of the capillary walls. The essayist has, however, made no attempt to differentiate between the effect of Vitamin C and that of the Svent-Györgyi factor, although he realizes that the latter may ultimately prove to be solely responsible for the changes in capillary fragility.

This investigation was carried out with the objective of determining whether a deficiency of anti-ascorbic vitamin in peptic ulcer as described by the above authors is sufficient to cause a lowering of the capillary resistance. The method used was that described by Göthlin. In this test the upper arm is compressed at a standard pressure so as to increase the pressure within the capillaries and then the number of ruptured capillaries is determined after a given time by counting the number of petechiæ visible within a given area of skin. A circle 60 mm. in diameter was marked out in the angle of the elbow. The petechiæ occurring within this area after compression of the upper arm at a standard pressure of 50 mm. of mercury were counted and the number recorded. In a total of 22 control patients there were 40 petechiæ or an average of 1.82. Twenty-eight patients with gastric ulcer showed 199 petechiæ or an average of 7.10. Fourteen ulcer patients had 103 petechiæ or an average of 7.36. In addition capillary resistance tests were done on 23 patients suffering from various other diseases. They showed an average of 2.86 petechiæ.

The author therefore concludes that, clinically, hospital patients on a dietary regimen for gastric and duodenal ulcer showed a degree of capillary fragility greater than that of normal subjects or patients suffering from other diseases. The histories of these patients indicates that the degree of capillary fragility is related to inadequacy of the diet with regard to anti-scorbutic vitamin, but no evidence was obtained that the development of peptic ulcer was conditioned by deficiency of anti-scorbutic vitamin in the diet. SAMUEL J. FOGELSON, M.D.

Eagle, P. C., and Gillman, J.: The Incidence of Peptic Ulcer in the South African Bantu. *South African J. M. Sc.*, 1938, 3: 1.

This study contrasts the incidence of peptic ulcer in Europeans, Eurafricans and Bantus at the Government Mortuary and the Johannesburg General Hospital. The material studied consisted of 15,296 autopsies. There were 4,773 Europeans, 43 of whom died from ulcer, an incidence of .901 per cent; there were 9,472 Bantus, 15 of whom died from ulcer, an incidence of .137 per cent; and there were 1,051 Eurafricans, 5 of whom died from ulcer, an incidence of .476 per cent.

Examination of these results shows that the incidence of peptic ulcer is highest in the Europeans and lowest in the Bantus. It is about three and a half times more common in the Eurafrican than in the Bantu and seven times more frequent in the European than in the Bantu; the European is apparently twice as susceptible to peptic ulcer as the Eurafrican. From this data it would be easy to conclude that the hill tribes are immune to peptic ulcer because of their diet and that the urbanized Indians are now more susceptible to ulcer.

Although diet may be important, the psychological factors may also play a causative rôle in the production of peptic ulcer. The isolation of the Himalayan tribes and their relatively settled life and peaceful living, as contrasted with the precarious existence and constant mental strain present in inhabitants of overcrowded cities, may explain to some extent the difference in the incidence of ulcer of these two distinct communities.

SAMUEL J. FOGELSON, M.D.

Boyd, L. J., and Schlachman, M.: The Meulengracht Treatment of Bleeding Peptic Ulcer. *Rev. Gastroenterol.*, 1938, 5: 43.

The authors report the cases of 30 patients with severe hemorrhage from peptic ulcer, who were admitted to the Metropolitan Hospital, New York. These patients were treated by the orthodox management of partial or complete starvation, followed by an ulcer diet, transfusion, venoclysis, and morphine. Six of them died.

Fifteen patients who were subsequently admitted, and who were treated by the Meulengracht method, have survived. They have had no recurrence of hemorrhage or of perforation. The unanimous opinion of the workers who have employed this method of treatment is that the newer Meulengracht regimen reduces the mortality rate to between 1 and 2 per cent. The mortality rate under the old Meulengracht regimen had been from 7 to 15 per cent.

Meulengracht has abandoned the old Luebe principle of inanition and under-nutrition in the treatment of patients with bleeding ulcer, for the following reasons:

1. The more carefully the old inanition regimen is carried out, the weaker the patient becomes and the more the mortality is increased.

2. Patients with ulcer often remain ambulatory after severe melena, without appreciating the significance of "tarry stools" and without a change of diet, and their course is very favorable.

3. Since posthemorrhagic shock and posthemorrhagic anemia form the most urgent indications for treatment following massive hemorrhage, the value of inanition, limited fluids, salts, calories, and vitamins is questionable.

4. It is doubtful whether emptiness of the stomach and the presence of unneutralized acid is suitable, either for hemostasis or for healing.

5. It is scarcely conceivable that an insufficient diet will promote regenerative processes.

These reasons must be considered further because there are early and late deaths resulting from hemorrhage in peptic ulcer. A small number of

patients have erosion of a major vessel and succumb within thirty-six hours. Any medical program for patients in this group would be more or less unsatisfactory. On the other hand, a considerable number of patients die from *exhausto virium* some time after the occurrence of hemorrhage. The subjective improvement of patients on the Meulengracht regimen is startling. They welcome liberal feeding and seem psychologically impelled to "eat to regain their strength." From an objective standpoint, patients are now out of bed within two weeks, instead of from five to six weeks. Nurses are impressed with the rapid improvement in the condition of their patients, and coöperate unusually well in carrying out the details of this regimen.

The authors do not conclude that any of their 15 patients were saved by the Meulengracht treatment, but their accumulated observations have been sufficient to convince them that the gastro-intestinal canal will tolerate a much greater latitude than was suspected prior to the liberal program of Meulengracht. This evidence indicates that the normal blood picture is more rapidly restored under a liberal regimen and that "greater liberality in feeding ought to characterize the posthemorrhage episode."

SAMUEL J. FOGELSON, M.D.

Haerem, S., Dack, G. M., and Wilson, H.: Acute Intestinal Obstruction. I. The Rôle of Bacteria in Closed Jejunal Loops. *Surgery*, 1938, 3: 333.

A study was made of the bacteriology and toxicity of the contents of obstructed bowel segments in 8 dogs, in an effort to isolate and identify the many organisms which are found in a closed intestinal loop. The clostridium welchii and bacillus coli were found to be the predominating organisms. The clostridium welchii organisms were found capable of the production of a potent toxin *in vitro*, in most instances. These studies did not show any definite evidence of clostridium-welchii toxin in the loop fluid, nor did they substantiate views that the toxemia of acute intestinal obstruction is due to the specific toxin of bacillus welchii.

RICHARD J. BENNETT, JR., M.D.

Haerem, S., Dack, G. M., and Dragstedt, L. P.: Acute Intestinal Obstruction. II. The Permeability of Obstructed Bowel Segments of Dogs to "Clostridium Botulinum" Toxin. *Surgery*, 1938, 3: 339.

The dog is known to be quite resistant to the oral administration of botulinum toxin, which is one of the most potent bacterial toxins and one which can be detected in very small quantities. Cultures of the clostridium botulinum were grown and then used in several experiments.

The clostridium botulinum did not pass through the normal intestinal wall of dogs when fed in quantities of less than 50 c.cm. The introduction of larger quantities occasionally resulted in the absorption of small amounts. When clostridium-botulinum toxin is injected intraperitoneally in large doses it is readily absorbed and may be demonstrated in the blood stream within two hours after injection, and in time it is lethal for the dog.

Acute experiments on intestinal obstruction made in dogs under varying conditions showed absorption of clostridium-botulinum toxin in the obstructed loops even when placed there in small quantities. The distention of the isolated loop was roentgenographed. There seems to be some correlation between demonstration of the toxin in the blood stream and distention of the loop. Gross necrosis of the distended loop did not always occur where there was absorption, but devitalization of the bowel segment certainly facilitated the appearance of toxin in the blood stream. RICHARD J. BENNETT, JR., M.D.

Guthrie, D., and Brown, M. J.: Diverticula of the Proximal Intestine: Duodenum and Jejunum. *Am. J. Surg.*, 1938, 39: 128.

In this article the authors have dealt first with a consideration of the pathology and anatomy, incidence, diagnosis, and treatment of diverticula of the duodenum. Routine fluoroscopic examination should include the upright, supine, and the modified Trendelenburg positions. Two cases, one of which had been reported previously, are reviewed. Both patients were females, one fifty and the other sixty-nine years of age, and both survived operation.

Under the heading of "Diverticula of the Jejunum" the authors discuss the history, incidence, pathology, pathogenesis, symptomatology, diagnosis, and treatment of the condition. They also present a summary of 4 cases reported previously, accompanied by 9 photographs and roentgenograms.

The article is summarized as follows:

The literature on diverticula of the duodenum and jejunum has been reviewed.

The difficulties in diagnosis of the diverticula are shown by the summary of the cases included here. The experiences of the authors are similar to those of others who have dealt with this problem, as indicated by their writings.

The principal factors at work in the production of diverticula are anatomical defects of the bowel wall at the points of entrance of the blood vessels, and increased intra-intestinal pressures.

The treatment of diverticula of the small intestine is surgical, but the location and extent of the lesions govern the type of surgery to be used in individual cases. CARL R. STEINKE, M.D.

Bartlett, M. K., and Lowell, W. H.: Acute Postoperative Duodenal Fistula. *New England J. M.*, 1938, 218: 587.

In a review of the literature from 1865 to 1937, a total of 130 reported cases of postoperative duodenal fistula were found. Excluding those cases which occurred more than three months after operation and which, therefore, cannot be classified as acute, as well as those cases in which sufficient data

were unavailable, the total amounts to 116. Twelve cases are added from the records of the Massachusetts General Hospital (Boston) for the past twenty years.

Two general types of duodenal fistula were seen: the lateral type, in which the opening is in the duodenal wall but the continuity of the gastro-intestinal tract remains intact; and the end type, in which the fistula results from leakage from the closed duodenal stump following gastric resection or pathological occlusion. The latter type is much less common. Certain fundamental factors, such as trauma, sepsis, and improper healing, lead to the production of duodenal fistula. Chemical changes, too, are brought about in patients with duodenal fistula: blood chlorides fall, sodium bicarbonate is lost, the carbon-dioxide combining power of the blood is increased, dehydration occurs, the non-protein nitrogen of the blood rises, and the serum protein falls.

The diagnosis of postoperative duodenal fistula usually presents no great difficulty. The treatment is divided into two phases: adequate local care of the wound, and systemic treatment to offset the effects of the loss of the duodenal contents. Several methods of local treatment are discussed. The general treatment consists of an adequate supply of fluid, salt, and glucose and, if possible, the establishment of an adequate means of introducing substances into the gastro-intestinal tract below the fistula. The authors suggest the passage of a small nasal tube through the stomach and into the duodenum, far enough to be effective, or the introduction of a tube through the fistulous tract into the duodenum. If these simpler methods are not effective, a jejunostomy must be done. The 12 cases studied in the hospital are reported.

HAROLD OCHSNER, M.D.

Allen, C. I.: Primary Carcinoma of the Duodenum. With a Report of 11 Cases. *Am. J. Surg.*, 1938, 39: 89.

Eleven cases of primary carcinoma of the duodenum were diagnosed in ten years at the Henry Ford Hospital, Detroit, Michigan; 6 of them have been reported previously. During this time 154,613 patients were seen; therefore this disease occurred in approximately 1 of every 14,000 patients admitted.

Brief histories with a comment on each are given. There are 4 illustrations and 1 chart. A summary comment on the 11 cases includes the location of the tumors, symptoms, examination, diagnosis, operation, and treatment. There were 8 different preoperative diagnoses made.

Of the 11 cases, 3 were rightly considered inoperable. The remaining 8 were operated upon. In 2 the tumor was not found at operation, and cholecystectomies were performed. In 5 cases the masses involving the duodenum and adjacent structures were palpated, but the condition was considered inoperable because of metastasis to the liver in 4 and to the pancreas in 1.

Only 3 palliative operations were performed, an ileostomy, a gastro-enterostomy, and a cholecystenterostomy.

Only 1 radical operation was done in which a resection of a portion of the duodenum with transplantation of the common duct into the stomach and a posterior gastro-enterostomy were carried out. The patient was still living at the time of the report.

Ten of the tumors proved to be cylindrical-cell adenocarcinomas and 1 a medullary carcinoma as diagnosed by Hartman. Post-mortem examination was made in 8 cases; 2 others terminated fatally.

CONCLUSIONS

1. The diagnosis of carcinoma of the duodenum is extremely difficult.

2. The syndrome of the author's cases was not diagnostic of anything other than a disease of the gastro-intestinal tract.

3. The presence of occult blood in the stool not otherwise accounted for should make one suspicious of a duodenal tumor. This finding is probably the most valuable aid in the differentiation of benign from malignant disease. Disregard of it will lead to mistaken diagnoses.

4. X-ray filling defects in the duodenum are helpful in diagnosis, but are often not seen. The development of a special technique for examination of the duodenum seems essential.

5. The operative treatment of duodenal tumors is an involved and difficult procedure. It is deserving of further development. CARL R. STEINKE, M.D.

Fowler, R. H.: The Rare Incidence of Acute Appendicitis Resulting from External Trauma. *Ann. Surg.*, 1938, 107: 529.

The correct evaluation of external trauma in acute appendicitis is important. Traumatic influences should be judged only on a very critical basis. This is purely a medical problem from the legal viewpoint. Court decisions rest entirely upon expert testimony, and the surgeon who appears as a witness should do so for the purpose of throwing light upon a subject of which the court is ignorant. It is conceded that the appendix is not immune to injury, but the majority of cases reported as traumatic appendicitis are misnamed.

In the evaluation of traumatic influence, five essentials must be correlated and united: (1) the history; (2) the force; (3) the mechanism; (4) the length of time elapsed following the accident; the development of the disease and operation; and (5) the pathology demonstrated at operation.

Appendicitis has been held a compensable injury by the courts, based upon its origin, aggravation, and whether it is the result of violence, either direct or indirect. Verdicts in general, regardless of whether the cases are the result of aggravation or origination, are equally divided between plaintiff and defendant. In cases of direct injury, the courts have favored the plaintiff in the ratio of five to one. In cases of indirect injury verdicts in favor of the plaintiff are two to one.

The following conclusions were drawn:

Appendicitis is a disease and not an accident. It cannot be produced by trauma alone. The primary cause of the disease is bacterial infection, occurring in a vestigial organ possessing low vital resistance, and susceptible to destructive changes on slight provocation. This provocation is furnished by slight abrasions of its mucous membrane from the presence of hardened fecal matter and especially by circulatory disturbances.

The question of the correct evaluation of trauma rests largely upon: (1) whether the patient has had previous attacks of appendicitis; (2) the character of the force; (3) the time element; (4) the bridging of symptoms from accident to operation; (5) the pathological findings at operation; and (6) the final microscopic diagnosis.

There are no proofs that chronic appendicitis can be attributed to trauma. If operation is refused, or if delayed and late operation reveals only chronic microscopic pathology, the case should not be accepted as one of traumatic origin. Lastly, if the attack following the accident subsides and recurs later, the injury should not be held responsible for the second exacerbation. JOHN W. NUZUM, M.D.

Mathewson, C., Jr.: Inflammatory Strictures of the Rectum Associated with Venereal Lymphogranuloma. *J. Am. M. Ass.*, 1938, 110: 709.

Frei first suggested that certain types of benign rectal stricture might be manifestations of venereal lymphogranuloma. Certainly all benign strictures could not be of this type, but many of the etiological theories suggested in the past cannot account for the condition. Diseases previously considered as factors were syphilis, tuberculosis, amebic dysentery, gonorrhea, and chancroid. Careful consideration of these factors readily convinces one that these diseases cannot account for most of the inflammatory strictures. The frequent finding of a positive Frei test in patients suffering with inflammatory stricture of the rectum is strong evidence that venereal lymphogranuloma is the real causative factor in the majority of cases.

The clinical picture of the disease in the rectum is characteristic. There is a history of bloody mucous discharge from the rectum, pruritus, and tenesmus, with intermittent periods of constipation and obstruction. The stricture is usually one of three distinct types. The first type consists of an annular diaphragm which is usually single but may be multiple. The second type of stricture is funnel shaped and feels granular on palpation. A third type may be very extensive and involve the entire bowel below the rectosigmoid junction.

Papillomas of the mucous membrane below the site of the stricture are almost invariably present in all three types. The early stages of the rectal lesion are seldom recognized. Patients suffering from this condition are often operated on for hemorrhoids, polyps, fissures, and fistulas. The earliest symptom is usually pruritus associated with mucous discharge. Proctoscopic examination shows a pouting of the mucous membrane with edema and swelling and considerable hyperemia. The infiltration may occur in a localized segment or may appear concurrently at several different levels. Ulceration may occur below the site of stricture.

The majority of investigators have come to the conclusion that the causative factor in the production of benign stricture is to be found in the disturbance of the lymph flow. The exact nature of this disturbance is not known. Chronic lymph stasis may lead to nutritional disturbance, which in turn may lead to ulceration, proliferation of the connective tissue, elephantiasis, and, finally, shrinkage and stricture.

Although specific changes may take place after invasion of the tissues with the virus of venereal lymphogranuloma, Mathewson has been unable to recognize them histologically as such except in the lymphatics.

Seventy-eight patients with benign rectal stricture in the San Francisco Hospital were studied. Forty of these patients were seen before the introduction of the Frei test, but a critical analysis of these cases in the light of present knowledge would bring all but 4 of them into the category of lymphogranuloma. The remaining 38 patients studied with the Frei test gave positive reactions.

The treatment of inflammatory stricture of the rectum is in general unsatisfactory. The result of drug therapy has been discouraging. Treatment by x-ray and radium has been of little value. The use of Frei antigen may at least check the advance of the disease. The lower bowel should be kept clean. Perirectal abscesses, if present, should be drained. Fistulous tracts should be excised and radical surgical procedures should be used only if obstruction occurs. Repeated dilatation of the strictures leads to unnecessary trauma and is, therefore, not advisable.

EARL GARSIDE, M.D.

LIVER, GALL BLADDER, PANCREAS, AND SPLEEN

Brendolan, G.: Six Clinical Cases of Biliary Peritonitis (Contributo di sei casi clinici allo studio del coleperitoneo). *Arch. ital. d. mal. dell' appar. digerente*, 1938, 7: 49.

Biliary peritonitis was first described by Barcellini in 1897 who observed a peritoneal effusion of about 10 liters of bile following a trauma, but an accurate description was given by Clairmont and Haberer in 1911.

From his own personal experiences and in agreement with the majority of the investigators, Brendolan believes that biliary peritonitis may be produced by filtration through the wall of the gall bladder, especially in those cases in which the wall is thin and distended. The transudation does not always take place through the entire wall but occurs only in certain places, at which the tissue has undergone profound alterations. According to Brendolan these

pathogenetic mechanisms are of practical importance to the surgeon, who should not prolong the operation unnecessarily while trying to find a perforation, which usually cannot be demonstrated.

In discussing the cause of biliary peritonitis, Brendolan believes that cholecystitis and cholelithiasis, especially if of the occluding type, predispose greatly to its development. The increased permeability is probably due to the inflammatory irritation of the gall-bladder wall which becomes gradually thinner.

Anatomicopathologically, a biliary peritonitis is characterized by the transudation of bile into the peritoneal cavity. Large quantities, of 10 or more liters usually accumulate. The fluid tends to accumulate in the more dependent portions of the cavity, especially in the iliac fossa. The transudate has the physical and chemical properties of bile mixed with pancreatic ferments.

Bacteriological examination reveals frequently the presence of pathogenic organisms, especially the bacillus coli, and less frequently the enterococcus, streptococcus, and staphylococcus. The peritoneum does not present any special pathological features. The gall bladder is usually found to be markedly enlarged, distended, and sometimes thickened and edematous. Multiple necrotic areas may be recognized. In a large percentage of the cases it contains multiple stones, but in other cases stones are absent and the condition probably develops as the result of a long-standing cholecystitis. Ulcerations and perforations have almost never been reported.

The necrosis may be extensive and may involve the entire thickness of the gall-bladder wall although the mucous membrane is usually attacked. Associated with the necrotic changes are acute and chronic inflammatory processes accompanied by the presence of stones.

There is usually a serobilious imbibition of the gall-bladder wall and various vascular changes may also be present.

Symptomatically the disease begins much like a moderately severe biliary colic. The patient begins to vomit and complains of pain in the right hypochondriac region which becomes gradually more intense and tends to spread over the entire abdomen. The course is less stormy than in cases of acute generalized peritonitis. The temperature is moderately elevated. Examination of the abdomen reveals at most a slight muscular rigidity.

The diagnosis is not always easy and the condition should be differentiated from appendicitis, perforated peptic ulcer, intestinal obstruction, pancreatic fat necrosis, and renal colic.

The prognosis is favorable in treated cases. Treatment is always surgical and the operation should be performed without delay. The author recommends a cholecystotomy rather than a cholecystectomy, followed by a thorough drainage of the biliary passages and of the subhepatic space in order to prevent the development of a subdiaphragmatic abscess.

RICHARD E. SOMMA, M.D.

Mixter, C. G., and Hermanson, L.: A Critical Evaluation of Cholangiography. *Am. J. Surg.*, 1938, 39: 223.

The authors point out the frequency with which choledochostomy is performed with negative findings. This frequency may be decreased by the use of cholangiography at the operating table in those cases in which doubt exists as to the necessity for this exploration.

The injection of hippuran through the cystic duct is preferred to puncture of the common duct to prevent bile leakage which necessitates drainage and to prevent obscuration of the picture by spilled contrast media. A second film is recommended after choledochostomy to determine the results of the operative procedure.

One hundred and five cases are reported; 39 of these showed normal cholangiograms and the ducts were not opened. Only 2 of the patients have had symptoms subsequently suggestive of stones in the common duct. For this reason the authors believe that the cholangiogram is not to be relied upon in the presence of small stones or bile sand in the common duct.

In 21 patients cholangiography was done before and after the common duct was opened. Two cases showed a block at the ampulla believed to be due to spasm since no organic pathology could be found. Eight cases showed a normal picture before the duct was opened; 7 of these pictures were proved correct, while 1 patient had stones in the common duct. Thus in this series 93.6 per cent of the findings were correct. Of the 13 patients remaining in this group all were diagnosed from cholangiograms to have obstruction. Eleven of the diagnoses were correct. The 2 errors were substantiated by later cholangiography. In 1 case there was no stone and in the other the stone was not found until a later operation.

Fourteen patients had cholangiography only after exploration of the common duct. Nine of these had stones in the common duct and after removal of the stones the cholangiograms were normal. The subsequent history of these patients has indicated the presence of more stones in the common duct in only 1. The remaining 5 patients in this group had no stones in the common duct on exploration; 4 of them had correspondingly normal cholangiograms. The fifth showed a dilated duct, but patent ampulla, in the cholangiogram. A subsequent choledochoduodenostomy was performed for the relief of the symptoms. The check-up cholangiograms were thus correct in 92.8 per cent of the cases.

Postoperative cholangiography is useful in the determination of when the drainage tube should be withdrawn and was proved correct in 94.7 per cent of 76 cases.

The authors state that cholangiography is unnecessary in those cases in which the history or examination of the ducts at operation is sufficient to indicate choledochostomy, but that as a check-up following such exploration it is invaluable.

THOMAS C. DOUGLASS, M.D.

Laird, S. M.: The State of the Heart in Gall-Bladder Disease. *Brit. M. J.*, 1938, 1: 884.

Laird reports a personal study of 65 consecutive cases of gall-bladder disease admitted to the wards of Mill Road Infirmary, Liverpool. The diagnosis of gall-bladder disease was based on the symptoms, clinical findings, and cholecystography.

All cases treated by surgery were studied during convalescence, examined carefully at the end of four weeks, and followed up for over a year. There was cardiac involvement in 50 of the patients. Twenty-four patients were regarded as obese. The presence of obesity in the operated cases appeared to mitigate the chances of cardiac improvement.

Thrombosis of the coronary artery occurred in 12 per cent of the cases of gall-bladder disease. Cholecystectomy produced a cure of the gall-bladder symptoms in 78 per cent of the cases. The presence of heart conditions in patients with gall-bladder disease does not constitute a contra-indication to cholecystectomy. Laird is of the opinion that gall-bladder disease is a definite etiological factor in myocardial lesions. EARL GARSIDE, M.D.

Estes, W. L., Jr.: Acute Gangrenous Cholecystitis and the Use of Partial Cholecystectomy in Its Treatment. *Am. J. Surg.*, 1938, 39:197.

Acute gangrenous cholecystitis is most commonly due to circulatory changes in the gall bladder, which occur as a result of the impaction of a stone in the cystic duct. Infarction and infection are usually secondary causes. The incidence reported by various surgeons varies from 12 per cent (Judd and Phillips) to 43 per cent (Estes) of all cases of acute cholecystitis. Perforation occurs in from 0.86 to 5.2 per cent of all cases of this condition treated in the hospital.

The author reviews the cases of 78 patients with acute cholecystitis. The condition was non-suppurative in 5 patients, suppurative in 39, and gangrenous in 34 patients. Perforation occurred in 9 cases, and produced a localized pericholecystic abscess in 7, and an acute general peritonitis in 2.

The difficulty of clinical diagnosis is noted.

Close observation is recommended in considering the method of treatment of acute gangrenous cholecystitis. For patients with symptoms of perforation with spreading peritonitis, immediate surgery is indicated. Careful preparation for surgery is stressed.

If operative treatment is decided upon, the author believes that cholecystectomy, if practical, is the method of choice. In cases of gangrenous and suppurative cholecystitis, a much lower mortality (2.08 per cent) has been shown when partial cholecystectomy has been performed. In this procedure, the free-lying portion of the gall bladder is excised, the wall is left attached to the liver, and the cystic duct is not disturbed. In a follow-up study of 42 patients who observed no dietary restrictions, 81 per cent showed no recurrence of symptoms and 11 per cent showed a residual fatty dyspepsia. Four patients were operated upon later for stones in the common duct. No vestige of a gall-bladder remnant was found in these cases. The mortality rate in this series is compared with that reported in acute cholecystitis, which ranged from 13.5 to 3.2 per cent.

Cholecystostomy is reserved for the patients who are very bad risks. THOMAS C. DOUGLASS, M.D.

Clute, H. M., and Albright, H.: The Complications of Gall-Bladder and Stomach Surgery. *Am. J. Surg.*, 1938, 39: 282.

The complications of gall-bladder and stomach surgery include all the possibilities for disturbances following any laparotomy. However, the authors consider only those most commonly related to surgery in these areas. Persistent fever usually indicates wound infection, cul-de-sac abscess, or subphrenic abscess. Inspection, palpation, and probing of the wound are necessary to demonstrate or exclude infection in the wound. Repeated rectal examinations may demonstrate a boggy collection of pus in the cul-de-sac. This should be evacuated when fluctuation is present. Subphrenic abscess appears more commonly on the right side but it was found on the left side in 2 instances in the authors' experience. It should be suspected: (1) when postoperative x-rays show a high fixed diaphragm with an obliterated or narrowed costophrenic angle; (2) when the x-rays show either pleural fluid or consolidation of the lung by pressure of the elevated diaphragm on the affected side; (3) when there is an air bubble beneath the diaphragm and above the liver; and (4) when the patient has an unexplained fever following upper abdominal surgery.

Respiratory complications such as pleurisy with effusion, pneumonia, and atelectasis may be found by physical signs or by the x-ray film.

Wound rupture may be partial or complete. At times the patient may feel something give way during a coughing or vomiting spell. This may be the origin of a ventral hernia. Immediate closure of the completely disrupted wound is most satisfactory. Adhesive strapping over sterile gauze is a very unsatisfactory makeshift.

Dehydration, hypochloremia, sodium chloride retention with edema, and embarrassment of the circulation from overloading are complications incidental to postoperative fluid balance. Hiccup is caused by irritation of the diaphragm or of a reflex arc involving the phrenic nerves. The cause should be sought according to the classification of Mayo. Prevention of distention by the early use of morphine, intestinal suction, and gastric lavage with sodium-bicarbonate solution may be helpful. Narcotics and sedatives, and carbon dioxide and oxygen inhalations for not more than fifteen minutes at a time usually are effective. If the hiccup persists more than seven days, interruption of the phrenic nerve pathway may be necessary. Cervical infiltration of the phrenic nerve with 2 per cent novocaine should be done on one or both sides with the patient under the fluoroscope, and the effect on the excursions of the diaphragm should be noted.

Injury to the common duct occurs most commonly because the duct is clamped during an attempt to control a bleeding cystic artery or because the common duct is pulled up with the cystic duct and is tied or cut off. Obstructive jaundice appearing within a few days after cholecystectomy, especially if not accompanied by pain, usually indicates injury to the common or hepatic ducts and in the authors' opinion demands an immediate secondary operation for correction.

Drainage of bile into the peritoneal cavity is dangerous because of the production of bile peritonitis. Distention, ileus, nausea, vomiting, and death may follow. This may result from too early removal or slipping of the T-tube in the common duct. If the patient's condition permits, re-operation with re-insertion of the tube is indicated.

Stones remaining in the common duct may be demonstrated by lipiodol injections through the T-tube. The use of ether to "dissolve" the stone has been reported.

Hemorrhage in a case of gall-bladder disease without jaundice usually indicates bleeding from an uncontrolled cystic artery stump or from damaged liver tissue, or oozing from a plexus of veins overlying the common duct. Serious hemorrhage warrants transfusions and re-operation to control the hemorrhage. In the jaundiced patient pre-operative preparation should be adequate with glucose, viosterol, and transfusions. Glucose administered post-operatively and repeated transfusions are found to be of value.

Postoperative hemorrhage in the patient with stomach disease indicates bleeding from the suture line or from an ulcer that has not been removed. Much more rarely esophageal or intestinal varix, or blood dyscrasia may be a cause. The authors recommend small transfusions, morphine, parenteral fluids, and glucose, and nothing by mouth.

"Liver failure" is a blanket term that in the absence of a post-mortem examination covers a variety of conditions associated with serious depletion of the vital forces. In the patient gravely ill with cardiovascular and renal disease the prospect of "liver failure" is great and efforts should be made to improve these organs.

Vomiting following gastric surgery occurs because of obstruction at the site of anastomosis from edema. The use of suction with full knowledge of fluid and chloride balance will overcome this difficulty. Jejunostomy has been done in the left upper quadrant under local anesthesia to supply the patient with the necessary proteins. Peritonitis is avoided by careful suture to prevent leakage and by the avoidance of contamination. The authors do not drain the site of the duodenal stump unless there has been soiling of the area or unless it is found that a not wholly satisfactory closure of the stump has been made.

Pancreatic or biliary fistula if persistent are serious and require reconstructive surgery.

MANUEL E. LICHTENSTEIN, M.D.

Dunlop, G. R., and Hunt, E. L.: Acute Pancreatitis. *New England J. M.*, 1938, 218: 376.

The authors report the cases of 14 patients with acute pancreatitis, with a mortality of 14.3 per cent. They agree with the contentions of Rich and Duff, and believe that the following sequence of events is logical in acute pancreatitis: (1) obstruction of the pancreatic ducts; (2) rupture of the duct-acinar system, due to back pressure; (3) escape of tryptic ferments; (4) necrosis of vessel walls; and (5) hemorrhage into the interstitial tissue with necrosis of the gland.

In these patients, the pain was less agonizing than that which is usual, and while generally referred across the upper abdomen, it was sometimes localized in either upper quadrant.

Pain which persists until shock supervenes is highly suggestive. While the pain is general in the upper abdomen, there is commonly a point of maximum tenderness about 5 cm. above the umbilicus. If the foramen of Winslow is open the irritating contents will spill into the general peritoneal cavity; otherwise this remains in the lesser omental sac.

Differential diagnosis may be very difficult and involve consideration of the corrosive poisons, coronary attacks, perforated appendix, ruptured duodenal ulcer, acute intestinal obstruction, rupture of a distended gall bladder, mesenteric thrombosis, ruptured ectopic pregnancy, and biliary-tract disease. In the majority of cases showing elevated blood sugar and elevated urine amylase, blood sugar determinations and the Wohlgemuth test for urine amylase proved of most value.

The treatment is surgical, and operation should be done at the moment which seems best to the competent and experienced surgeon. Such a surgeon will allow no unnecessary loss of time in the fulminating case, will not hurry in the less acute case, and will not neglect suitable measures to combat shock, relieve emesis, and restore the acid-base balance.

The surgical aims are: (1) to complete the diagnosis by accurate visualization of the lesion; (2) to drain away any tryptic ferments by drainage of the lesser omental sac; (3) to decompress the pancreas by multiple nicking of the peritoneal covering of the gland; and (4) to decompress an obstructed pancreatic duct system by drainage of the biliary tract by the method that seems most appropriate to the patient's condition. The complications, which may be many and varied, must be treated as they arise.

JOHN WILTSIE EPTON, M.D.

Cole, W. H.: Acute Pancreatitis, with Special Reference to Pathogenesis and the Diagnostic Value of the Blood Amylase Test. *Am. J. Surg.*, 1938, 39: 245.

Cases of acute pancreatitis may be divided roughly into two types: the acute edematous, or interstitial type, and the acute hemorrhagic, or necrotic type. It is possible that the acute edematous type is caused primarily by obstruction, while the acute

necrotic type occurs as a result of tryptic digestion within the gland. The symptoms in the former type are milder and are never associated with shock. Analysis of the various clinical reports, in addition to the author's observations, shows an increase in blood amylase in acute pancreatitis only. This is about as reliable in the acute interstitial forms as in the fulminating forms, except that a normal or low reading may be encountered more frequently in the latter group. There is a rise of blood amylase from its normal level of 90 to a level of 150 within a few hours, and in a day or two this may be as high as 1,000. (Readings are expressed in terms of milligrams of sugar produced by the amylolytic action of 100 c.cm. of serum on a given amount of starch.) The blood amylase level falls gradually until the normal threshold is reached within two or three days after the onset of the symptoms. It may return to normal many days before the symptoms subside, although often there will be a direct correlation between the return of blood amylase to normal and the subsidence of symptoms.

Urinary diastase determinations are of diagnostic value. However, there is a great variation between blood amylase and urinary amylase. The test is positive in more than 50 per cent of the cases of pancreatic cysts. In carcinoma of the pancreas the test shows an increase in only a few cases. In chronic pancreatitis the test is negative.

A low blood-amylase level, in the light of recent work, is an indication of hepatic disease. The author observed such an instance in a patient with considerable destruction of the liver by cysts. A low amylase level may be found after a sudden elevation in the amount of amylase in the blood stream. The liver and pancreas cease to produce amylase during the period of elevation, but although the elevation disappears within a few days, the return to normal production takes from eight to twenty days.

MANUEL E. LICHTENSTEIN, M.D.

Joachim, H., and Banowitch, M. M.: A Case of Carcinoma of the Islands of Langerhans with Hypoglycemia. *Ann. Int. Med.*, 1938, 11: 1754.

Most of the numerous cases of spontaneous hypoglycemia due to pancreatic tumors reported in the past ten years have been due to hyperfunctioning adenomas of the islands of Langerhans. Islet carcinoma as a cause of this syndrome has been relatively rare.

To the 7 cases previously reported the authors add another, which occurred in a woman thirty-one years of age. Vague symptoms had been present for one month, and recurrent convulsions and coma for three days. Laparotomy revealed a pea-sized indurated gland along the lesser curvature of the stomach, and in the terminal half of the pancreas a nodular mass about the size of a tangerine, and several large glands. The spleen had to be removed to get at the mass in the pancreas. Only part of the tumor could be removed. Sections showed carcinoma of the pancreas with lymph-node metastases. Convulsions and coma occurred four days after operation and daily thereafter in spite of almost continuous glucose administration. The patient died forty-two days after operation. The sella turcica was definitely small, but otherwise normal, roentgenologically. No autopsy was obtained and no attempt was made to demonstrate the presence of insulin in the tumor tissue.

WALTER H. NADLER, M.D.

MISCELLANEOUS

Marshall, S. F., and Lahey, F. H.: The Surgical Treatment of Abdominal Fistulas. *New England J. M.*, 1938, 218: 211.

The authors present a study of fistulas arising from the small and large intestine, together with reports of illustrative cases, including a case of pancreatic fistula in which the patient was successfully operated upon.

The most common cause of abdominal fistula is infection which produces gangrene and perforation of the bowel. Fistula may also be caused by injury to adjacent loops of bowel during an operative procedure. Severe trauma to the abdomen may be the primary cause of a fistula, of which the case of pancreatic fistula reported in this paper is an example. The following table outlines the cases of abdominal fistula arranged according to etiology:

TABLE I.—CASES OF ABDOMINAL FISTULA

Etiological Factor	No. of Cases
Appendicitis, perforated	10
Diverticulitis of sigmoid, perforated	9
Regional ileitis, perforated	4
Pelvic operation (other than for tuberculosis)	4
Pelvic operation (with tuberculosis)	2
Carcinoma of colon	3
Trauma to abdomen	2
Gastric operation	2
Richter's hernia, ileum	1
Total	37

A complete history frequently gives more accurate information as to the origin of the tract than the roentgenological examination; nevertheless, the latter should always be made so as to establish the existence of obstruction, which is often present, and also to indicate the pathological condition involved, such as regional ileitis, diverticulitis, and fistulous communication with other viscera.

Many operations for the closure of abdominal fistulas result in failure because the underlying pathological condition has not been recognized. A general discussion of the principles involved in the surgical treatment is given. Many fistulas will close spontaneously. Those, however, which are persistent, or which have certain underlying pathological conditions require operations which, in most cases, are extensive and serious.

Six cases of fistulas are reported, together with the operative method employed for the eradication of the fistula in each case. These are well illus-

trated. In the authors' series of 37 cases, 27 patients were submitted to operation. Five died after operation; this was an operative mortality of 19 per cent.

JOHN H. GARLOCK, M.D.

Benedict, E. B.: Peritoneoscopy. *New England J. M.*, 1938, 218: 713.

The author uses the Ruddock peritoneoscope for direct inspection of the abdominal and pelvic cavities. The biopsy forceps is equipped with a small telescope so that biopsies can be taken under direct vision. A diathermy connection permits coagulation of the bleeding points.

The author states that when patients are carefully selected peritoneoscopy is attended with very little risk. Patients with serious pulmonary or cardiac disease are not good risks. Abdominal adhesions may complicate the procedure, but by careful selection of the site of puncture the author has avoided difficulties. Ruddock is quoted as having punctured the bowel in 8 of 500 examinations but without contamination of the general peritoneal cavity. Such examination is contra-indicated in inflammatory conditions.

Peritoneoscopy may be indicated in any abdominal or pelvic condition when the diagnosis is obscure or when additional evidence is needed for confirmation of a diagnosis or for a decision as to the type of treatment. The information thus obtained will frequently be the deciding factor, for or against laparotomy. The author has found peritoneoscopy useful in cancer, cirrhosis, tuberculous peritonitis,

Fig. 1. Typical appearance of small, cirrhotic, hobnail liver.

ascites, pelvic tumors, ectopic pregnancy, and ovarian dysfunction.

He states that the advantages of peritoneoscopy are that it is a minor procedure performed under local anesthesia through an incision 1 cm. in length, and that it requires only one day of hospitalization.

In two years the author has made 48 examinations, and in 1 case he believes that pneumoperitoneum may well have been a contributory cause of death. No true errors in diagnosis were made. An ovarian cyst was aspirated under direct peritoneoscopic vision in 1 case, that of a woman eighty-nine years of age.

EARL O. LATIMER, M.D.

GYNECOLOGY

UTERUS

Bernabei, D.: Biology of the Lower Uterine Segment (Sulla biologia del segmento uterino inferiore). *Folia demograph. gynaec.*, 1938, 35: 23.

The author presents an exhaustive review of the literature on the biology of the lower uterine segment and then attempts to correlate these various clinico-experimental contributions.

All evidence points towards the lower segment as being an autonomic, distinct structure with the same anatomical, physiological, and pathological characteristics as the corpus and the cervix during the gravid, puerperal, and non-gravid states. It is from 0.5 to 1 cm. long. Its limits are not exact, but it extends approximately from the point of peritoneal reflexion anteriorly on the uterus to the angle of antiflexion with the cervix, and the cavity includes that portion between the triangular cavity of the corpus and that portion of the cervical canal where the plica transversalis of the cervical mucosa has its beginning.

The microscopic limits are distinct: the cavity is the straightest portion of the uterine canal; the mucosa is more smooth than that of the corpus; the epithelium is lower and contains nuclei which are situated near the center of the cell; the glands are arranged exactly opposite those of the corpus and the cervix, being lower externally and higher internally, and they have a cystic tendency.

The walls of the lower uterine segment are prevalently muscular and stand out in contrast to the corpus by having elevated segments, spiral muscle fibers, and in sagittal section give an appearance of a circular fibrous structure.

The blood supply seems to be autonomic. The lymphatic circulation is common with that of the cervix. Its innervation is by way of the ganglion of Frankenhauser, with rich sensorial endings, both superficial and deep, and many autonomic nervous-system ganglia. It participates only lightly in the premenstrual and menstrual phases of menstruation.

During pregnancy it participates in the same modifications as the corpus but is less marked in the first trimester. After the third month the muscle fibers, having been contracted, relax, and the mucosa undergoes decidual transformation to a lesser degree than that of the corpus. During the third trimester the lower segment becomes thinned and is distinctly limited by the corpus and the cervix. At term the height of the lower segment measures from 6 to 7 cm. and comprises approximately one-third of the uterine cavity. During parturition the membranes are adherent to practically all of the spongy layer of the lower segment mucosa.

The musculature contracts less actively than the corpus and with diverse effect from that of the corpus during the period of dilatation.

After labor this so-called isthmus retracts rapidly to return to its normal state, while its cavity only partially returns to its pregravid state.

During pregnancy the mucosa may be the site of placental insertion in part or completely, and the walls may become rigid or spastic and obstruct labor, or may be the site of rupture from various causes.

And finally it would appear that the lower segment of the non-gravid uterus forms a barrier to pathological, inflammatory, or neoplastic processes of the cervix which might invade the uterus.

GEORGE C. FINOLA, M.D.

Cotte, G, and Notter, A.: Cancer Developing in the Cervical Stump Following Subtotal Hysterectomy (Sur la cancérisation du moignon cervical après hystérectomie subtotale). *Gynéc. et obst.*, 1938, 37: 161.

Apropos the discussion at the recent Congress of the French Gynecological Society on cancer developing in the cervical stump after subtotal hysterectomy, the authors report their clinical observations on the subject extending over a period of fifteen years.

Brief résumés of 7 cases are presented. Five of these were treated by radium and x-ray irradiation and 2 by operative means. One of the 2 patients operated upon died. Cures were reported after thirteen, twelve, and two years, six months, several weeks, and several days, and 1 patient could not be followed up.

In all of these patients the carcinoma originated after a minimum of three years following subtotal hysterectomy and in no instance was there evolution of a pre-existing cancer. Only in one instance have the authors ever observed an unrecognized cancer of the cervix, a pre-existing ulcerative lesion of the cervix, which developed rapidly soon after a subtotal hysterectomy.

Among 250 neoplasms of the cervix observed over a period of seventeen years, the authors report the incidence of cancer of the cervical stump as 3 per cent. For the Anticancer Center of Lyon, Ponthus gave a statistical report of 9 cases of cervical-stump cancer in 960 neoplasms of the cervix, or approximately 1 per cent. Monod gives .54 per cent. The authors do not concur with the statement that cancer of the cervical stump is more prone to follow subtotal hysterectomy performed for the removal of fibroids because in their series only 2 patients were operated upon for fibroids.

From the standpoint of therapy, all those cancers which fall into Classes I and II of the Geneva Classification should respond well to either surgical treatment or that treatment which employs physical agents; except that surgery, particularly of the Wertheim type, is much more difficult after subtotal hysterectomy.

The success of radium therapy in carcinoma of the cervix is well recognized, and since cancer of the cervical stump does not differ from cancer arising from the cervix, the authors believe that radium therapy is the treatment of choice.

GEORGE C. FINOLA, M.D.

ADNEXAL AND PERIUTERINE CONDITIONS

Dannreuther, W. T.: The Frank-Geist Operation for Congenital Absence of the Vagina. *Am. J. Obst. & Gynec.*, 1938, 35: 452.

The author reports the case of a patient nineteen years of age, upon whom he performed the Frank-Geist operation successfully. The article is well illustrated.

The Frank-Geist technique includes three distinct operative steps, with minor procedures occasionally interspersed, numerous dressings, and meticulous attention to detail. The first operation consists of making a skin flap 6½ in. long and 3 in. wide on the inner aspect of the thigh and converting it into a pedicled tube. The skin edges are slid together beneath the tube and approximated with interrupted silk sutures. After three weeks the distal attachment of the tube flap is incised slightly on each side under gas or local anesthesia. The detachment is carried further a few days later, and only a small area of attachment is left in the center.

The second operation is done about four weeks after the first. The narrow remaining attachment of the distal extremity of the flap is completely severed and the line of union on the under surface of the tube is re-opened throughout its entire length. After trimming the scar tissue from the cut edges, the flap is temporarily wrapped in a large gauze pad which has been wrung out in hot saline solution. The tissue partition occluding the vaginal space is incised transversely and two of the operator's fingers are insinuated between the bladder and rectum up to the peritoneal reflection.

The flap is then inverted so that the skin surface is inside, and draped over a hard rubber vaginal plug of appropriate size, through the top of which a small hole has been drilled. After proper disposition of the tissue over the plug so that the pressure is everywhere equalized, the lateral margins of the flap are fastened together with 3 plain catgut sutures. The pedicle is rotated 180 degrees toward the vaginal introitus and the flap-covered plug is inserted into the newly created vesicorectal space. Three or four interrupted sutures fix the free end of the flap to the vaginal orifice. A Pezzer self-retaining catheter is introduced into the bladder and left for eight days. Continuous pressure on the vaginal plug is maintained by means of an overlying rubber sponge and a tight "T" binder. At the end of two weeks the new lining of the vaginal canal is found tightly adherent to the adjacent tissues, so that the vaginal plug can be removed and replaced at the patient's convenience. By the end of the third week, when the entire field is dry, the detachment of the flap from the covered margin of the vaginal canal can be started. It is severed little by little, as in the case of the distal extremity.

The third operation consists of completing the detachment of the flap at the vaginal orifice, freshening the granulating area and skin margins at the base of the flap, introducing a few more catgut sutures at the introitus, and replacing the severed tongue of skin flap in the bed from which it originated.

EDWARD L. CORNELL, M.D.

Puente, J. J.: Anatomicoclinical Forms of Lymphogranulomatous Vulvovaginal Lesions and the Anorectal-Genital Syndrome (Formas anátomo clínicas de la estiomene de la vulva y del síndrome anorectogenital). *Rev. méd. Lat.-Am.*, 1938, 23: 367.

Puente states that in its evolution venereal lymphogranulomatosis presents in the female certain peculiar clinical features which are quite different from those encountered in the male.

After having exposed some of the clinical and epidemiological aspects of the problem, which has still remained obscure in some of its phases, the author classifies, from a practical point of view, these types of lesions into 4 groups: (a) lymphogranulomatous lesions localized exclusively at the external genitalia (esthiomene, chronic ulcerative elephantiasis of the vulva, anterior syndrome); (b) lesions localized exclusively at the anorectal region (anorectal syphiloma of Fournier, proliferative and stenosing anoproctitis); (c) a combination of the two forementioned forms (anorectal-genital syndrome); (d) lesions localized in the internal genitalia with or without rectal lesions. The author is primarily interested in lesions mentioned under groups (a) and (c).

Lymphogranuloma of the vulva (esthiomene) is defined by the author as a polymorphous affection of the external female genitalia, characterized by a slowly progressive clinical course. The condition is often subjectively asymptomatic. The most common manifestations are (a) ulcerations of the vulva, which may be superficial or deep. The lesions present irregular borders and rest upon a reddish-blue base. They are indolent and resist all treatment; (b) nodules and abscesses, especially at the labia majora; (c) fistulas which are constantly present in all processes complicated by the presence of rectal lesions. Other clinical manifestations include the presence of fibrous bands, velvety and myrtiform vegetations, edema of the urinary meatus and elephantiasis.

The author excludes from this group a certain lesion which has been called "simple chronic ulcer of the vulva" which according to all presumptions is not due to venereal infection but may result from ovarian insufficiency, repeated traumatism, and certain pathogenic or saprophytic organisms.

Jersild's anorectal-genital syndrome is characterized by the presence of a proliferating and stenosing anoproctitis, firm condylomas and fistulas

in addition to the vulvar lesions. In a certain proportion of cases, general manifestations make their appearance, such as fever, constipation, and skin eruptions. Lesions in the fundus of the eye have also been described, such as papilledema and vascular tortuosities.

Concerning the cause of these conditions, 152 of a series of 170 patients reported in the literature gave a positive reaction to the Frei test. The incidence of concomitant syphilis, soft chancre, and gonorrhea varies greatly according to those authors who studied the problem. The gonococcus does not seem to be implicated in the production of these lesions. In a number of cases a definite lymphogranulomatosis had to be excluded and the condition was attributed either to tuberculosis or to syphilis. Amebic dysentery has been regarded by some as being etiologically related to some lymphogranulomatous processes, especially those involving the rectum exclusively.

Since 1924 the author has observed 7 cases of lymphogranulomatosis which illustrate well the forementioned clinical picture. In 4 patients the Frei test was frankly positive; in 1 case the test was at first negative but later became positive; the last 2 cases were observed prior to the advent of the diagnostic Frei test but their clinical course was typically that of lymphogranulomatosis.

It is interesting to note that in one of the patients of this series there was found at autopsy a marked amyloidosis and an infiltrating and stenosing process in the terminal portions of the large intestine resembling grossly and microscopically the lymphogranulomatous lesions usually encountered in the rectum. Only one case of this kind has been published in the literature.

After having briefly discussed the anatomicopathological and pathogenetic features of this disease group, the author concludes that the edema and elephantiasis of the vulva are consequences of an obstruction along the regional lymphatics produced by the granulomatous process, and not, as Jersild believes, consequences resulting from the destruction and blockage of the deep lymphatic circulation.

RICHARD E. SOMMA, M.D.

Hamar, A., and Goebel, A.: The Symptoms and Treatment of Carcinomas of the External Genitalia. II Mitt.: Primary Urethral Carcinoma (Zur Klinik und Therapie der Carcinome am ausseren Genitale. II Mitt.: Zur Klinik und Therapie des primaeren Urethralcarcinoms). *Zentralbl. f. Gynaek.*, 1937, p. 2526.

There were 14 cases of primary urethral carcinoma, and 7 cases of cancer designated as "vulvo-urethral" that were not utilized for the main statistical purposes given in this article. The authors state that during the period from 1932 to 1936 the frequency of urethral carcinoma as compared to all carcinomas was 16 per cent, gynecological carcinoma 55 per cent, and vulvar carcinoma 23 per cent. In the 14 cases described in detail the average age of the patients was fifty-six and five-tenths years. Two patients were thirty-six years old, and 2, more than seventy years old. According to their histories, the disease existed during variable periods of time, but most frequently it had not begun longer than three or four months before the patient was admitted to the clinic. The papillary form of carcinoma was most frequent; it was found in 9 cases. In 5 cases the tumor infiltrated into the deeper tissues. Histologically there were 3 squamous-cell carcinomas, 2 cylinder-cell, one basal-cell, and one epithelial-cell carcinoma of the urinary passages, and one papillary carcinoma. In 4 cases no particular type of carcinoma was designated. Twice carcinoma was suspected as positive clinically, and as almost positive after pathologico-anatomical examinations.

No operations were performed; instead, local irradiation with radium followed by roentgen-ray treatment over the region of the groin was given. In the more extensive involvement of the inguinal gland, extirpation was done; this was done in 2 of the cases here reported. The first 7 cases were treated by superficial radium irradiations; the last 7 were treated after 1931, with radium needles. The dose of the superficial treatment was from 4,500 to 5,000 roentgens, i.e., in 1 cm., with a depth of about 50 per cent. The dose of the radium needles was from 3 to 8 needles, each of 1 mgm. placed deeply and parallel to the urethra, which was followed by a short superficial treatment of from 800 to 1,275 mgm/Elstd. According to photometric measurements on the phantom this is equivalent to 6,500 roentgens delivered in the tumor. It must be noted, and it is also emphasized by the authors that the radiation treatment was not exclusive inasmuch as some of the tumors were curetted, wasted, ligated, or excised. The excisions were done by them more for diagnostic than for therapeutic purposes. One patient had no recurrence in sixteen years after mere diathermic cauterization of a raspberry-size papillary carcinoma and extirpation of the inguinal glands with mesothorium implantation.

In the summary the authors state that the total number of cases was 14; 3 of these were incurable and not treated; the number treated was 11. Eight of the patients are living and free from all symptoms; 4 of 7 are living for longer than five years. There was 1 intercurrent death after two and one-half years; 1 death occurred from an unknown cause (section in this case showed no cancer); and 1 death was the result of cancer.

The experience of the authors shows that the papillary tumors are more amenable to cure than the infiltrating types. If to the 14 primary urethral carcinomas the afore-mentioned 7 vulvar tumors with vulvo-urethral foci are added and included in the statistics, 12 of the 21 cases were symptomless; and 6 of the 10 cases showed a five-year cure.

In an appendix 2 cases of primary urethral cancer are discussed; these came for treatment after these reports were completed. The report of these 2 is

accompanied with a photographic demonstration of the findings and roentgenological control showing the beds of the radium needle.

(KRAATZ). MATHIAS J. SEIFERT, M.D.

MISCELLANEOUS

Zondek, B.: Menstruation-Like Hemorrhage in Rabbits Induced by Gonadotropic Hormone. *J. Obst. & Gynaec. Brit. Emp.*, 1938, 45: 1.

The author prefaces the report of his experiments by a discussion of the interrelationship of the hormones of the ovary and the anterior lobe of the pituitary gland with respect to menstruation. It has been observed that menstruation can be delayed in the human being by the administration of large doses of follicular hormone. There are two possible explanations: (1) the follicular hormone directly inhibits the development of the corpus luteum and, thus, the formation of progesterone, and the progestational phase of the endometrium, or (2) the follicular hormone indirectly suppresses the development of the corpus luteum by inhibiting the production of Prolan B, the luteinizing hormone, by the anterior lobe of the pituitary gland. The author believes that the latter explanation is correct, as he has achieved partial suppression of the function of the anterior lobe in rats and chickens by prolonged estrone administration. He states that folliculin inhibits the secretion of Prolan B and causes an overproduction of Prolan A. As the pituitary gland seems definitely to be an important link in the suppression of menstrual bleeding by follicular administration, *per contra* the pituitary gland is probably responsible for the initiation of the impulse for the bleeding of menstruation.

The work of Smith, Tyndale, and Engle is discussed. These authors produced menstrual bleeding in hypophysectomized monkeys by first injecting estrone for ten days to cause endometrial proliferation, and then progesterone for another ten days to convert the proliferated endometrium into the progestational type. Menstruation occurred three days after the last injection. This work seems to indicate that menstruation is caused exclusively by the ovarian hormones, quite independently of the anterior lobe of the pituitary gland. Zondek is skeptical of this and wonders what substance determines the duration of life of the corpus luteum and, thus, the duration of progesterone production. He speculates that it might be the shift in the ratio of Prolan A to Prolan B, or possibly a special bleeding hormone produced by the pituitary gland quite independent of the follicle-stimulating and luteinizing principles.

Various kinds of uterine hemorrhages are distinguished. It is pointed out that a variety of substances may produce uterine bleeding which is not true menstruation. True menstrual bleeding is that which occurs into a mucosa which has first been stimulated to proliferate by folliculin, and which is later converted to the progestational type by progesterone.

Although menstruation does not occur as a normal physiological part of the sexual cycle of rabbits, the author was able to produce pseudomenstruation in these animals by the intravenous injection of gonadotropic hormone. The bleeding was similar to that of menstruation in that it was a hemorrhage into the proliferated, folliculin-stimulated mucosa, with uprooting of the mucosa and the escape of blood into the uterine cavity and the vagina. This occurred only after intravenous injection. Both prolan from pregnancy urine and prosylan, gonadotropic hormone derived from pregnant mare's blood, were equally effective. This effect could be produced about four times as frequently in infantile animals as in mature animals. In some of the uteri there were areas of true progestational changes in the endometrium. Bleeding occurred only in the proliferative areas, never in those showing progestational changes. The author deduces from this that the corpus-luteum hormone and its stimulant, Prolan B, suppress bleeding, not cause it.

In other animals, this type of bleeding could not be produced by the administration of estrone, estradiol, nor progesterone. On the other hand, pseudomenstruation could not be produced in castrated animals by first injecting folliculin, to cause proliferation of the endometrium, and later, prolan. The author concludes that "there must be a third, separate factor in the ovary which is important for the bleeding mechanism." He further believes that the ovarian bleeding factor is mobilized by Prolan A, and not by a third pituitary principle.

The types of experiments are described in detail. A number of drawings, some in color, illustrate the type of bleeding produced.

DANIEL G. MORTON, M.D.

Schleyer, E.: Reciprocal Relations Between the Inflammatory Diseases of the Female Genital Organs and the Rectosigmoid Flexure, and Their Treatment (Ueber Wechselbeziehungen zwischen entzueundlichen Erkrankungen des weiblichen Genitales und dem Rectum-Sigmoid, sowie ihre Behandlung). *Wien. klin. Wchnschr.*, 1937, 2: 1519.

The following results were obtained from a systematic investigation with the rectoscope in inflammatory diseases of the female genital organs, as well as from gynecological explorations, in cases of proctosigmoiditis:

Of 100 women with inflammatory disease of the adnexa and parametrium, 72 had proctitis or proctosigmoiditis and 28 had a normal rectoscopical condition. The largest percentage of proctitis (79.1) was found to be on the left side, while the number on the right side was 26.7 per cent and the percentage of ambilateral cases was 77.7. Proctitis was present in 83.3 per cent of the cases of posterior parametritis. Of 50 women with proctitis or proctosigmoiditis, 16 or 32 per cent had a normal gynecological condition, 24 or 48 per cent had a parametritis or adnexitis, especially on the left side, as well

as posterior parametritis. As a control, a number of patients with non-inflammatory genital tumors, myomas, cysts, and tubal pregnancies, were subjected to a rectoscopic observation. Of 50 such cases, 43 or 86 per cent had a normal rectoscopic condition; 7 or 14 per cent had proctitis. As a proof of the intimate connection between the inflammatory genital diseases and ailments of the rectum and the sigmoid flexure, 6 histories of disease were reported. In this connection, one must be prepared not only for a possible invasion of inflammation from the genitalia into the lower intestine, but also for the opposite process. It is not always easy to say which organ is to suffer first. In most cases, constipation plays an important rôle.

In the therapy of inflammatory diseases of the female genital organs, it is necessary to take into consideration the adjacent part of the intestine. If the existence of proctosigmoiditis is revealed, it will be necessary to treat it first, in which case the therapy consists in effective measures to suppress constipation, such as insufflation with dermatol, or a cehasolbolus under rectoscopical control, and eventually "torantil" injections. During the differential diagnosis between the inflammatory and non-inflammatory genital tumors, the rectoscopic findings can furnish an important indication revealing a normal tumor more as a non-inflammatory, and a sigmoiditis more as an inflammatory, genital tumor. The reason why a large number of women suffering with genital diseases fail to be freed from their condition is that the adjoining sigma, or the rectum, is also diseased or is even the cause of the inflammation. (Hans Heidler). Clarence C. Reed, M.D.

Dougal, D.: The Problem of Endometriosis. *Am. J. Obst. & Gynec.*, 1938, 35: 373.

In the author's own series of 241 cases of external endometriosis, one or both ovaries were involved in 103 patients, the rectovaginal space was involved in 62 patients, and the ovaries and rectovaginal space in 71 patients. In the remaining 5 patients the lesions were in other situations.

Pelvic infection and new growths of the uterus and ovaries, either benign or malignant, may be complicated by endometriosis; but, with the exception of uterine fibroids, their association is too rare to be anything but accidental. For every 100 cases of uterine fibroids there are 6 cases of internal and 25 cases of external endometriosis, and the latter is encountered as the principal lesion, or as an important complication, in not less than 10 per cent of all abdominal operations on the female genital organs.

Menorrhagia or epimenorrhagia was complained of in about 40 per cent of the cases, and may be extremely severe, especially if the uterus is involved.

Eighty-eight per cent of the patients between the ages of thirty and fifty were operated upon; 28 per cent of these were under thirty-five years and 10 per cent were under thirty. Twenty per cent of the patients were single. Excluding women in whom there were associated uterine fibroids, single women, and women who had been married less than three years, 40 per cent of the remainder were sterile, 32 per cent had not been pregnant for at least ten years, and 23 per cent had not been pregnant for at least five years.

When the lesions are extensive, treatment must be radical, either surgical or radiological. The author prefers to remove the uterus, together with both appendages, preferably by total hysterectomy. It is unnecessary and, in fact, dangerous to dissect outgrowths from the bowel wall. Only 2 of his patients have become pregnant after conservative treatment, and a considerable number have not obtained complete relief. There were 3 deaths in 262 operations, 1 from peritonitis and 2 from embolism, an operative mortality of a little over 1 per cent.

Edward L. Cornell, M.D.

OBSTETRICS

PREGNANCY AND ITS COMPLICATIONS

Johnstone, R. W.: The Interaction of Pregnancy and Associated Disease. *Brit. M. J.*, 1938, 1: 765.

Until the early part of the present century, general medical diseases associated with pregnancy, while not wholly in the province of either the obstetrician or the physician, were generally regarded as "complications" of pregnancy, and treated as such by the obstetrician. Nowadays the obstetrical specialist is almost always also a gynecologist, and therefore he is more inclined to the study of surgery than of medicine. Endocrinology in relation to gynecology has been leading him back in some degree to medicine. However, rarely has the obstetrical specialist been able to keep pace with the developments of modern medicine. The co-operation of physicians in cases of pregnancy and labor associated with general disease is more frequently noted. The author believes these cases ought usually to be regarded as instances of pregnancy complicating general disease.

In 4 series of maternal deaths in Great Britain (2 analyzed officially, and 2 unofficially), the deaths of 25 per cent, based on the lowest computation, and of 40 per cent, based on the highest computation of the totals, are attributed to associated diseases. In each of these series of deaths the same 3 disease groups were found to dominate the picture almost to the exclusion of anything else, namely: heart disease, non-tuberculous respiratory disease, and kidney disease.

The death of mothers is not the whole tragedy; there is the comparative fruitlessness of the fatal pregnancies. In other words, the effect of the diseases upon the pregnancies, or upon the health of the child if born alive, is the corollary of the dangerous effect of pregnancy upon the disease. In the 1935 Scottish report covering over 2,000 maternal deaths, only 40 per cent of the infants were born alive. This figure includes a very large number of obstetrical emergencies, and is not confined merely to cases of associated diseases. If from the latter are chosen the main disease groups, the following figures are obtained:

Maternal deaths due to:	Fetal deaths per cent
Heart disease	59
Non-tuberculous respiratory disease	70
Renal disease (including pyelitis)	68
Tuberculosis	55
Anemia (? plus malnutrition)	42

Corresponding figures for 2,136 maternal deaths in Scotland were essentially the same.

The incidence of heart disease was below 1 per cent in 39,000 pregnancies in Scotland, and yet in both English and Scottish reports it was responsible for over 4.9 and 7.5 per cent, respectively, of the total maternal deaths from all causes, both obstetrical and medical, and in each series was responsible for about 25 per cent of the deaths attributed to associated diseases. Thus the importance of these associated diseases is noted. They account for between one-quarter and one-third of the maternal deaths, and in the mothers who survive they cause definite ill health in 10 per cent of the cases; and lastly, a huge wastage of fetal and neonatal life is the result.

Disease means that some organs are partially disabled. Pregnancy means that increased demands are put on all the mother's organs. Therefore, if pregnancy occurs in a woman who is already suffering from disease, it superimposes conditions of strain upon already disabled organs; while if disease originates after the pregnancy has already begun it introduces an element of disablement to the pre-existent conditions of strain. To watch how the diseased organs behave under the new conditions becomes a fascinating study, while to determine whether the experiment may safely be allowed to continue, or whether, and just when, it must be interrupted calls for the exercise of wide knowledge and nice judgment. The author illustrates his thesis by discussing the modern treatment and prognosis in cardiac disease, the latest ideas on anemia in pregnancy, the relation of Vitamin B to polyneuritis, and the change in our conception of diabetes since the advent of insulin. ROBERT M. GRIER, M.D.

LABOR AND ITS COMPLICATIONS

Colvin, E. D., and Bartholomew, R. A.: Improvements in the Paraldehyde Method of Relief of Pain in Labor. *Am. J. Obst. & Gynec.*, 1938, 35: 589.

Complete amnesia as to pain in labor can be obtained in fully 98 per cent of the cases through the use of paraldehyde. The technique has been simplified by the oral administration of 24 c.cm. of the drug. Facilities for restraint of the patient's wrists to the sides of the bed should be available, better to protect the patient and lighten the duties of the attendant. Pituitary extract dropped into the nose is a valuable and safe aid in overcoming any prolongation of a temporary inertia. Control of the patient for final cleansing, draping, and delivery is greatly facilitated by the induction of light primary ether anesthesia during crowning of the head, just before moving the patient to the delivery room.

A mild degree of apnea or sluggishness in breathing or crying is to be expected in about 12 per cent of full-term, normal babies but is of no serious significance and is easily overcome. If paraldehyde is given in premature labors, coramine should be given to induce more prompt and thorough expansion of the lungs. The incidence of forceps delivery is not increased. EDWARD L. CORNELL, M.D.

Wetterdal, P.: Some Notes on the Premature Rupture of the Membranes. *Acta obst. et gynec. Scand.*, 1938, 18: 45.

The author reports the study of 1,022 cases of labor in which there was a loss of amniotic fluid prior to the onset of pains. Two distinct groups were noted: those labors completed within eighteen hours and those taking more than eighteen hours. In the former, the complications amounted to only 15 per cent and in the latter to 42 per cent. In parturitions starting long after the passage of water the time taken by the actual labor may be very short and complications then are, as a rule, very few. In parturitions starting soon or late after the premature passage of fluid, when the labor is long (over twenty-four hours), the complications are numerous. This is believed to be due to weak and ineffective pains. Figures show that the risk is especially great when the discharge of waters is soon followed by weak, ineffective labor. Such cases must be regarded as dangerous and requiring special attention; the parturition must be assisted by suitable means, among which are included the administration of thymophysin and digital dilatation of the os uteri. The author warns against combining quinine and thymophysin as in his experience this may easily lead to cramp-like labor. He does not believe that premature rupture causes the primary weakness of pains, but that this is a primary factor.

A study was made also to determine whether there was an increase in physical or psychical defects, or perhaps a higher mortality at birth or later. It is conceivable that the more or less dry labor resulting in a premature rupture of the bag might increase trauma due to parturition, more particularly as the os uteri will then be dilated by direct pressure on the head of the fetus instead of by pressure against the membranous bag. Two thousand children were studied and there was no difference whatever between the group delivered after premature rupture and the total group, in either spontaneous or forceps deliveries. ROBERT M. GRIER, M.D.

Kretzschmar, N. R., and Huber, C. P.: A Study of 2,987 Consecutive Episiotomies. *Am. J. Obst. & Gynec.*, 1938, 35: 621.

The authors report on 2,987 consecutive episiotomies from the standpoint of immediate healing, coincident morbidity, incidence of infection, and end-results. They believe that a sufficiently large series has been summarized to eliminate the majority of errors which might be due to individual factors. The following conclusions are presented:

1. Infection of the episiotomy wound is a minor but significant cause of puerperal morbidity.

2. The incidence of infection is greater in those cases in which the condition is repaired with silkworm-gut suture, but the average infection in this group is less severe.

3. The incidence of infection in both types of repair increases rapidly with the complexity of associated obstetrical procedures.

4. The morbidity and end-results depend upon factors other than the type of suture material used in the repair. EDWARD L. CORNELL, M.D.

PUERPERIUM AND ITS COMPLICATIONS

Abramson, M., and Berman, I.: Factors Affecting the Blood Loss in the Third Stage of Labor. *Am. J. Obst. & Gynec.*, 1938, 35: 626.

The present study is based on an analysis of 1,658 births at the Minneapolis General Hospital, Minneapolis, not including multiple births, cesarean sections, and certain incomplete records.

Of all the factors studied, none has any marked relation to the blood loss. The age of the mother, her blood pressure, and probably her gravidity have no measurable effect; the height and weight of the mother and the total length of labor have a very small but significant relation. The weight of the infant and the weight and area of the placenta are related a little more closely to the blood loss. On the average, the tall heavy woman who has a long labor will lose more blood than the short thin woman who has a short labor. On the average, too, a large baby and a large placenta will result in a greater loss of blood than a small baby and a small placenta.

Not one of these factors, however, approaches the importance of the management of the third stage of labor, for it is through the improved technique of management that the average blood loss has been reduced from over 500 c.cm. at the beginning of the century to about 225 c.cm. at the present time. EDWARD L. CORNELL, M.D.

Ross, J. R.: Prolactin—Its Effect on the Secretion of Woman's Milk. *Endocrinology*, 1938, 22: 429.

Prolactin was administered intramuscularly to mothers whose daily breast milk secretion on the fifth and sixth days was less than 400 c.cm. The injections were given twice daily over a two-day period. One group of patients received a total of 400 U., whereas the second group received a total amounting to 1,000 U. A control group of patients received intramuscular injections of normal saline solution.

Administration of the higher concentration of prolactin appeared to increase slightly the secretion of breast milk during the remainder of the patients' stay in the hospital. Of much more significance, however, was the fact that 7 of 11 patients receiving this higher concentration of prolactin, whose records could be followed after discharge from the hospital, nursed their infants completely, whereas of 8 such observed patients receiving the lower concentration of prolactin, only 2 were able to nurse their infants completely. Of the 8 patients who received normal saline solution, only 1 nursed her infant completely.

Rather severe local reactions followed the injection of the large amount of prolactin. It is probable that further purification of prolactin will eliminate these reactions. The administration of prolactin apparently has no effect on the fat protein or ash con-

tent of the breast milk secreted. The galactagogue effect which was obtained justifies further investigation of the value of this product. The urinary excretion of estrin in these cases was within the range found during the normal menstrual cycle.

J. THORNWELL WITHERSPOON, M.D.

MISCELLANEOUS

Husmann, W.: Injuries of Mother and Child Resulting from Abnormal Pelvic Presentations (Schaedigungen von Mutter und Kind bei Beckenendlagen). Duesseldorf: Dissertation, 1937.

The author discusses the obstetrical material of the Woman's Clinic of the Academy of Duesseldorf with reference to the injuries sustained by the mother and child in abnormal pelvic presentations. These statistics are based upon 9,229 labors occurring between April, 1928, and April, 1935. From all the pathological presentations (5 per cent), the nonviable and twin cases are deducted, which leaves 3.17 per cent for statistical studies. Among these, there were breech presentations in 80.8 per cent; foot presentations in 18.5 per cent, and knee presentations in 0.7 per cent.

Among the 461 abnormal presentations, 67 per cent of the mothers or children sustained injuries, 3 patients died (0.65 per cent), 2 after cesarean section although during labor fever was already present. The third death resulted from a post-partum paralytic ileus. Excluding these 3 cases, 133 (29 per cent) prophylactic episiotomies were done and 7 cervical-os incisions; in 59 cases (13 per cent) lacerations occurred.

The various lacerations were tabulated and given in percentages; among these was one rupture of the uterus following manual liberation and extraction of the placenta. Primipara were injured 4.4 per cent more frequently than multipara. Atonic postpartum hemorrhages occurred in 31 cases (6.7 per cent); 5 patients had an elevation of temperature during labor; and 74 (16 per cent) had puerperal temperatures. An incipient rupture of the bag of waters occurred in 19 per cent, and a premature rupture in 4.8 per cent of the cases. Following these 109 labors, there was a puerperal temperature in 22 per cent.

Among the 461 abnormal presentations, 26.7 per cent of the babies died, 87 in the uterus, 36 after delivery. After deducting premature children and twin labors, the author records an infant mortality of 9 per cent.

The statistical report closes with reference to the relationship between infant asphyxia and the mechanism of tentorial lacerations of the newborn.

The appendix contains several clinical histories of abnormal pelvic presentations.

(ALBERS). MATHIAS J. SEIFERT, M.D.

GENITO-URINARY SURGERY

ADRENAL, KIDNEY, AND URETER

Wesson, M. B.: Renocolic Fistulas. *J. Urol.*, 1938, 39: 589.

In this article the author reports his experience with 3 cases of renocolic fistula which were treated by nephrectomy and closure of the fistulous opening into the gut.

Before a renocolic fistula can form, according to the author, there must exist a chronic inflammation

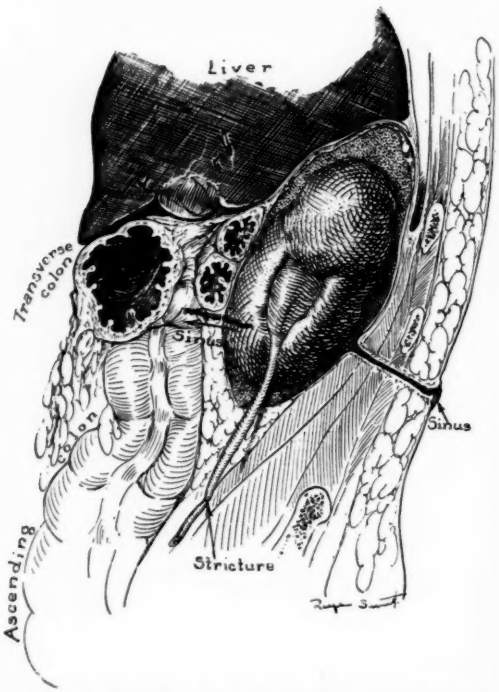

Fig. 1. Perirenal abscess with resultant renocolic fistula, external sinus, and ureteral stricture. A loop of duodenum lies between the colon and the kidney directly above the sinus.

of the kidney associated with a perinephritis or perinephritic abscess. The 3 cases reported occurred as a result of (1) tuberculosis, (2) infection, and (3) stone.

The author arrives at the conclusion that renocolic fistula is not such an uncommon condition as the literature would lead one to believe.

D. E. MURRAY, M.D.

Dean, A. L., Jr.: Radiation Therapy of Tumors of the Renal Parenchyma in Adults. *J. Urol.*, 1938, 39: 303.

The author claims that the closest co-operation between urologists, radiologists, and pathologists is required to establish scientifically our knowledge of tumors of the renal parenchyma and their treatment. The urologist should assume the full responsibility for the management of each patient. He must know the natural history of these tumors, and make a clear-cut diagnosis of the presence of a renal tumor, the extent of its local development, and the presence of metastases. The pathologist assists in making a pre-operative diagnosis if biopsy aspiration is employed and classifies the tumor after its removal. He must give the final opinion regarding the efficacy of pre-operative irradiation. The greatest value of aspiration biopsies is that of the differentiation between cysts and tumors. The use of irradiation can be evaluated by careful gross and microscopic studies of tumors which have been removed following treatment by irradiation. Tumors of the renal parenchyma in adults are distinctly radioresistant. Since there may be no difference in the microscopic picture between the natural changes and those caused by irradiation, the pathologist cannot determine exactly the amount of change to attribute to irradiation in a given case.

The urologist is justified in the following evaluation of external irradiation by the usual high-voltage units in the management of tumors of the renal parenchyma in adults:

1. External irradiation alone cannot be relied upon to cure these tumors.
2. Pre-operative irradiation will probably decrease the size of the tumor from 20 to 40 per cent, which may greatly facilitate nephrectomy.
3. External irradiation will not make an inoperable tumor operable. Inoperable tumors are those which penetrate the renal capsule. Large size alone does not constitute absolute inoperability, as the surgeon's skill is an important factor.
4. If tumor cells are disseminated by trauma, pre-operative irradiation may partially, but not entirely, prevent the disaster.
5. During pre-operative irradiation and the subsequent period in which the radiation takes effect, metastasis may occur.
6. If a renal tumor is only partially removed, postoperative irradiation may slow up the recurring growth, but will not stop it.
7. There is considerable difference in the radiosensitivity of metastases. Metastases in bones are only slightly inhibited, while pulmonary metastases may disappear.

If irradiation is to be employed, the patient and all of his diagnostic data should be referred to the radiologist, who should be told whether pre-opera-

tive, postoperative, or exclusive irradiation is to be employed. The radiologist's procedure should be as follows: (1) accurately locate the tumor for the placement of skin portals; (2) choose the most efficient combination of factors for the x-ray unit employed; (3) adjust therapeutic details so that (a) violent reactions will not occur in the tumor, (b) maximal regression will occur, (c) nephrectomy will not be prevented or delayed because of injury to the skin or superficial tissues, and (d) the general health of the patient will be maintained; (4) compute the tissue dose received by the tumor and assist the pathologist in correlating changes found in the tumor with the dose of irradiation given.

The therapeutic details, with the use of a 200 kilovolt unit outfit, are as follows:

The pre-operative cycle includes 3 skin portals (anterior, lateral, and posterior), each about 10 by 14 cm. in size; a target skin distance of 70 cm.; a filtration of 2 mm. of copper; and a daily dose of 250 roentgens to a single portal, making a total of 2,500 roentgens to each portal. In a man weighing about 150 lb., this will amount to about 5 threshold erythema doses. This cycle consists of 30 treatments in a month. The blood should be kept in good condition, checked by counts every five or seven days and, if necessary, transfusion should be given.

If the tumor is inoperable, or if postoperative irradiation is required, 4 portals are advantageous. Other factors are the same as in pre-operative irradiation, and all of the skin covering the side of the body at the level of the affected kidney is used. As much as 3,000 roentgens may be given each portal. This provides a substantially larger depth dose and the region of the renal pedicle receives more than 7 threshold erythema doses. In favorable cases, after a suitable rest period, this cycle may be repeated either wholly or in part. LOUIS NEUWELT, M.D.

McNeill, W. H., Jr., and Chilko, A. J.: The Status of Surgical and Irradiation Treatment of Wilms' Tumor, and a Report of 2 Cases. *J. Urol.*, 1938, 39: 287.

Many urologists have declared that nephrectomy offers the only hope for the cure of Wilms' tumor. It is believed by some that x-ray irradiation preoperatively, followed by nephrectomy, is the best method of treatment. A small group of surgeons favor x-ray irradiation and nephrectomy, followed by another course of x-ray therapy, or radium packs postoperatively. No one, with the exception of Pohle and Ritchie, has given x-ray therapy a full trial with any measure of success. Dean and Pack, in 1932, stated that irradiation alone was of no value and that no patient at the Memorial Hospital, New York, had been cured by irradiation alone, with the equipment available at that time. They stated that after x-ray irradiation has been given and the tumor was reduced in size, nephrectomy should be performed. They believe that the radiosensitivity of these growths depends upon their congenital origin, embryonal structure, and unstable vascularity, the high rate of metabolism of the tumor cells, and the anatomical character of the cells. Some investigators believe that x-rays reduce the size of Wilms' tumor but that the tumor becomes radioresistant after repeated exposures, thus necessitating increasingly large doses to keep it confined. There are others who believe that although irradiation reduces the size of the tumor, it has something to do with the production of metastases.

In a series of 383 cases reported in the literature, or seen personally, the mortality rate was more than 90 per cent. Six types of treatment were followed: (1) nephrectomy alone; (2) serum in conjunction with nephrectomy; (3) x-ray therapy followed by nephrectomy; (4) x-ray therapy and nephrectomy, followed by another course of x-ray therapy; (5) nephrectomy followed by postoperative x-ray treatment; and (6) x-ray therapy alone. With the latter procedure, success has been reported by Pohle and Ritchie in the cases of only 2 patients who were under treatment for from three to three and one-half years.

The authors report the case of a boy, fourteen months of age, with a movable, non-tender mass about the size of a large orange in the right loin. There were no other symptoms and the urinalysis and blood count were normal. Complete roentgenographic examination of the child confirmed the presence of an enlarged kidney and the absence of metastases. Pyelography confirmed the diagnosis of Wilms' tumor. Irradiation was started at once and the kidney reacted immediately, and at the end of one month the mass was hardly palpable. The child was under treatment for almost three years and was given 10,319 roentgens of x-ray irradiation. There was no skin reaction at any time and the child steadily gained in weight. Pyelography now shows the affected kidney to be greatly reduced in size, and even slightly smaller than the opposite kidney. The child is reported to be alive and well three years after the inception of irradiation.

The authors also report the case of a boy six years of age, with a mass the size of a small orange in the right loin, which was discovered during a routine examination. Thorough clinical study was delayed and the mass had reached the size of a watermelon at the time of operation, one month later. A section of the mass revealed a Wilms' tumor. Because of the large size of the tumor, the kidney was not removed. The wound healed, and several x-ray treatments were given without any noticeable improvement. Death occurred about four months later.

In view of the appalling results of other methods of treatment, the authors believe that x-ray treatment is worthy of further trial and investigation.

LOUIS NEUWELT, M.D.

SURGERY OF THE BONES, JOINTS, MUSCLES, TENDONS

CONDITIONS OF THE BONES, JOINTS, MUSCLES, TENDONS, ETC.

Pereira, S.: The Influence of Vascular Disturbances on the Growth in Length of the Bones (L'influence des troubles de la vascularisation sur la croissance des os en longueur). *Rev. d'orthop.*, 1938, 25: 140.

A series of experiments were carried out on young rabbits to determine the influence of vascular disturbance on the growth in length of bones.

The main artery of an arm or leg was ligated, and in other cases ligated and sectioned, at the base of the member. There was no difference between the growth in length or thickness of the bone on the side operated on from that on the normal side. Roentgenograms of the bones made repeatedly after ligation or section of the main artery showed no difference from those of the normal leg. The cartilages of the two tibiæ studied microscopically presented no distinct differences.

After ligation of the femoral artery and vein there was no difference noted between the growth of bone in either length or thickness on the operated from that on the non-operated side. Repeated roentgen examinations taken after ligation of the vessels showed no difference between the bones of the legs which were operated upon and those which were not. Microscopic study of the cartilage of the inferior extremity of the tibia of the operated leg and the corresponding cartilage of the tibia of the opposite leg (non-operated) showed that there was no appreciable morphological difference between the two. The organization of the cartilage and the ossification were uniform on the two sides. The depth and thickness of the beds of cartilage had not been modified by the ligation of the large vessels. The same results were obtained in experiments on both anterior and posterior extremities.

The artery and vein of a member were ligated and then both sectioned. There were no growth differences in the length or thickness of the bone between the members which were operated upon and those which were not. The roentgen examinations of the bones repeated after ligation and section of the right femoral artery and vein showed no difference between the leg which was operated upon and the normal leg. Cartilages at the distal extremities of the forearm have not been modified in their morphologic structure. When the cartilages of the posterior extremities were compared with the corresponding region of the normal side, very slight diminution in the growth of the cartilage on the side operated upon was noted. It was not accompanied by any modification of the different details of the morphological structure of the cartilage. The small difference between the cartilages of the two sides had not influenced the growth. Roentgen examinations showed little evidence of any appreciable inequality in the length or the thickness of the two bones.

In order to determine the vascular disturbance during the process of endochondral ossification by direct action on the vascularity of the diaphysis, the circulation of the diaphysis was disturbed by sectioning the bones 1½ cm. proximal to the distal cartilage of the posterior extremity. Furthermore the distal 1½ cm. portion of bone was isolated entirely from the surrounding structures although the periosteum was not touched.

Temporary interruption of the vascularity of the bones was obtained; roentgen studies of the bones of these animals showed that growth in the length of the bone has not been limited. The production of callus allowed the diaphysis to resume its continuity and the process of ossification so that the roentgenogram did not show any modification of growth. Histological examination showed that the cartilage of the side operated upon was quite similar to the normal cartilage of the opposite leg. There was no morphological difference in the thickness of the different cartilages or of the morphological or cellular elements of which they are made.

In another series of rabbits, vascularity was disturbed either by (1) resection of periosteum and the perichondrium of the inferior half of the diaphysis of the forearm, or (2) resection of all the periosteum of the diaphysis and the perichondrium between the superior and inferior cartilages. Here definite changes in the growth in the length of the bone was noted. Repeated roentgen examinations showed definite bony changes. Histological examination of the cartilages at the distal extremity of the two forearms did not show any notable modification.

Resection of the periosteum of the diaphysis between the superior and inferior conjugating cartilages and resection of the perichondrium of the two conjugating cartilages were performed. Results showed that the bones were not as long as the normal.

The conjugating cartilages had preserved their normal structures but their thickness had been diminished. In another experiment this result was much more accentuated as shown by shortening of the diaphysis. The conjugating cartilage had undergone profound changes, the thickness varying considerably, and the normal structure was lost. Ossification was also found to be very irregular and retarded.

The findings in this group of experiments would suggest:

1. The vascularity of a bone must be very markedly disturbed in order to modify endochondral ossification and the growth in length of bone.

2. Temporary diminution of the vascularity of a bone either by ligation of the large vessels or by interruption of all the vascularization of the diaphyseal segment adjacent to the conjugating cartilage

does not alter the normal growth in the length of bone.

3. The growth of bone has been modified in those cases in which the diaphysis has been entirely isolated from its vascularity as well as in which resection of the diaphyseal periosteum and perichondrium of the conjugating cartilages has been performed.

4. It is assumed that the periosteum and the perichondrium play an equal rôle along with the vascularity in the growth in length of the bone.

RICHARD J. BENNETT, JR., M.D.

Harrison, J. H.: Epidermoid Carcinoma in Osteomyelitis: Case Report. *Am. J. Cancer*, 1938, 32: 527.

Only one case of epidermoid carcinoma in osteomyelitis is reported among 365 cases of osteomyelitis cared for during a period of twenty-two years at the Peter Bent Brigham Hospital in Boston.

A forty-seven-year-old woman gave a history of injury to her left leg eighteen years previously. The course of this case was osteomyelitis with both operative and spontaneous drainage from the left tibia. Two fractures of the left tibia had occurred before the patient was admitted to the hospital for treatment.

Physical examination revealed extreme emaciation, pallor, bilateral inguinal lymph-node enlargement, and the disease process in the left leg. The left leg from the knee to the ankle including the entire anterior, medial, and lateral aspects was ulcerated and had many sinus-tract openings. The leucocytes in the blood numbered 12,800 per c. mm.; the erythrocytes 3,850,000 per c. mm.; and the hemoglobin was 55 per cent. Biopsies of several regions of the granulated surface of the skin edge showed epidermoid carcinoma. Roentgenograms demonstrated irregular thickening of the soft tissues and a picture compatible with chronic osteomyelitis in the middle and lower thirds of the tibia. A mid-thigh amputation was performed under spinal anesthesia. The patient made an uneventful recovery. Two courses of 750 roentgen units were administered.

On microscopic examination all sections taken from the external aspects of the leg showed the nodular tissue to be composed of epidermoid cancer of a fairly well differentiated type. Acute and chronic inflammatory reactions were present throughout the neoplastic tissue. A section from the osteomyelitic cavity again showed epidermoid carcinoma. Other portions of bone from the tibia and fibula showed acute and chronic osteomyelitis.

Carcinoma developing in osteomyelitic foci is one of slow progression. Because of the tendency of the tumor to remain localized a good result may be expected after amputation of the involved limb. No case of carcinoma secondary to osteomyelitis in which there was distant metastasis has been found in the literature. Biopsy of nearby enlarged lymph nodes has shown only chronic lymphadenitis.

In the case reported, the patient was well and without evidence of metastasis twenty-four months after operation. RICHARD J. BENNETT, JR., M.D.

Tavernier and Dechaume: Volkmann's Paralysis (A propos de la paralysie de Volkmann). *Rev. d'orthop.*, 1938, 25: 97.

Two cases are presented which were observed and operated upon three days and three weeks, respectively, after the onset of Volkmann's paralysis. The authors state in an unquestionable manner that the elementary lesion is an infarct in the subaponeurotic region of the forearm.

The first case was that of a girl eight years old who developed a supracondylar fracture of the right humerus with considerable anteroposterior displacement. The fracture was reduced under anesthesia and a splint applied. On the next day the arm was found to be swollen and the fingers anesthetized and paralyzed. On the third day, operation was performed through a long incision over the anterior portion of the right elbow. The superficial muscular aponeurosis was found to be very tense and dark in color. Incision of the aponeurosis relieved this marked tension and the color changed from black to a good red. A week after operation anesthesia and paralysis of the fingers still persisted.

A second operation was performed seven weeks following the first at which time the median nerve was found between the broken humeral fragments.

Seven months following the second operation there was great improvement although the fingers were still in contraction. One year following the first operation the hand was still in a contracted position although the sensory changes had entirely cleared up.

Five years following the first operation there still remained a simple contraction of the flexors. When the wrist was flexed to 135 degrees the fingers could be extended almost completely and the action of the fingers and thumb in this position was almost complete.

Pathological examination of a piece of muscle removed at the first operation showed the muscular fibers to be normal. There were practically no white blood corpuscles present and the diagnosis of hemorrhagic infarct was made.

The second patient was a boy, ten years of age who injured his wrist and received no immediate treatment. After three weeks there was considerable pain and he was seen by a doctor and the forearm was immobilized.

This patient was seen two weeks later at which time the hand had the typical claw appearance.

Operation was performed twenty-five days after application of the splint. A very thickened muscular aponeurosis was found. The muscles were very tense, firm, and dark. The median nerve was found in the fibrous tissue near the middle of the forearm and after being liberated, appeared to be about half its normal diameter. The median nerve was transplanted.

The results in this case were only mediocre. Some flexion and extension of the fingers could be carried out. The flexor muscles of the forearm were more supple than in those cases which were not operated upon.

Pathological examination showed that the muscular fibers were badly broken and interspersed with fibrous tissue. There was a very marked sclerosis without the evidence of inflammatory elements. The diagnosis of ischemic infarct was made.

In the first case the cause was apparently due to compression of the veins at the site of fracture and in the second case the origin was a definite constriction of the arteries.

Secondary operations, such as those carried out after several days or several weeks after the original operation, make possible the freeing of nerves and correction of the vicious or defective callus, and have produced remarkable results.

The results in these two cases lead the authors to believe that early intervention in cases of this type will give a much better end-result than in those cases which are allowed to progress without intervention. The choice of several procedures for use in late cases for relief of deformities and contractures is discussed. RICHARD J. BENNETT, JR., M.D.

Milch, H., and Green, H. H.: Calcification About the Flexor Carpi Ulnaris Tendon. *Arch. Surg.*, 1938, 36: 660.

The authors report a series of cases exhibiting a new clinical syndrome of which very little has been mentioned in the literature. These cases typically show sharply localized pain and tenderness over the area around the pisiform bone, limitation of motion at the wrist, occasional signs suggesting an inflammatory reaction, and a characteristic roentgenogram.

Although there is a basic similarity in all the cases some patients develop a hyperacute form which is hard to differentiate from an infection. The other cases are acute, and with or without calcification about the flexor carpi ulnaris tendon.

No definite etiological factor can be established. Some cases suggest an infectious origin, others have a definite history of trauma or overuse. The authors believe that clinically the course of the disease is such to suggest a traumatic origin.

Apart from the tenderness and swelling over the pisiform bone and the limitation of motion of the wrist the characteristic feature is the appearance of a radio-opaque substance situated near the pisiform bone. The calcified mass may be circular, oval, or elongated, and probably the size and shape depend on the stage of the process and the intensity of the reaction. The calcification disappears with the subsidence of the clinical symptoms.

Since no pathological material has been obtained the authors have been forced to infer that the location of the calcium deposit is either the flexor carpi ulnaris tendon, the peritendinous soft tissues, or an occasional bursa near the tendon. They believe it is located in the tendon.

Clinically, the condition must be differentiated from a stenosing tendovaginitis or an acute infectious process, such as cellulitis or osteomyelitis.

Usually, simple rest or a splint, the application of heat and the administration of salicylates result in a prompt disappearance of the symptoms.

HARVEY S. ALLEN, M.D

Brown, H. A.: Enlargement of the Ligamentum Flavum. A Cause of Low Back Pain with Sciatic Radiation. *J. Bone & Joint Surg.*, 1938, 20: 325.

The literature was reviewed and 17 cases of enlargement of the ligamentum flavum were found to have been reported previously.

The history and symptoms of this condition are essentially the same as those of rupture and dislocation of a portion of an intervertebral disc and clinical differentiation between the two conditions is extremely difficult or impossible. In many instances these syndromes cannot be differentiated clinically from lumbosacral or sacro-iliac disorders.

Subjectively there is a history of a relatively slight trauma. The interval between the onset of the pain in the back and radiation to the leg varies from a few hours to several months.

Seven additional cases are reported in this series. In patients with enlargement of the ligamentum flavum, the pain is usually severe and often disabling; sensory disturbances, such as numbness and paresthesia, may be present, and there is likely to be some degree of motor weakness in the involved extremity. The symptoms are usually unilateral but may be bilateral.

Objectively there is usually some degree of scoliosis with a list to the unaffected side and there is a general restriction of movements of the back and limitation in raising the straight leg on the involved side. The most constant single finding was a decrease in the Achilles-tendon reflex on the side of the lesion. Sensory disturbances of varying degree were present over the buttocks, the posterior aspect of the thigh, the calf, and the foot. The most common sensory alteration appeared over the outer aspect of the lower part of the leg and the dorsum of the foot.

Spinal puncture and the use of lipiodol are usually required for the diagnosis. An increase in the total protein content of the spinal fluid above 50 mgm. per 100 c.cm. is suggestive of an intraspinal pathological process and was present in 3 of the 4 cases in which this determination was made. At least 4 c.cm. of lipiodol should be used.

The enlargement of the ligaments occurred between the fourth and fifth lumbar vertebræ in 6 patients and at the lumbosacral junction in 1.

An increase in the size of the ligament, a posterior protrusion of the disc, or a combination of the two, serves to compress the nerve root at its point of emersion.

Treatment consists of laminectomy and a wide lateral removal of the enlarged ligament in order to

free the nerve root from compression. In all cases a careful search was made to determine the possible presence of a ruptured intervertebral disc. In 2 cases a very small prominence of the disc was noted in association with the enlarged ligamentum flavum. Any undue prominence of the disc, however, serves to decrease the size of the passage of the nerve root, so that even a moderate enlargement of the ligament would compress the root against it.

In most of the author's patients, rapid relief of the pain and gradual improvement in the impaired motor and sensory function followed removal of the ligament.

Seven cases are reported in detail, the first laminectomy being performed on February 17, 1937. The article was received for publication seven months later. During this time 7 laminectomies were performed. A further follow-up of these cases will be necessary in order that the end-results be reported accurately.

RICHARD J. BENNETT, JR., M.D.

FRACTURES AND DISLOCATIONS

Vulliet, M.: The Evolution of Fractures in Children (Remarques sur l'évolution des fractures chez l'enfant). *Rev. méd. de la Suisse Rom.*, 1938, p. 80.

Vulliet notes that in the last twenty years the number of fractures has greatly increased; economic considerations have made it necessary for surgeons to use such methods in treatment as give the best possible functional result in the shortest possible time. Many techniques of dealing with fractures have been developed and the general practitioner is sometimes in doubt as to the best method to use.

In adults the growth of the bones is completed and the process of repair of the bone is limited to the fracture and its immediate neighborhood; dislocations and displacements that have occurred tend to persist and overriding fragments result in a permanent shortening of the bone.

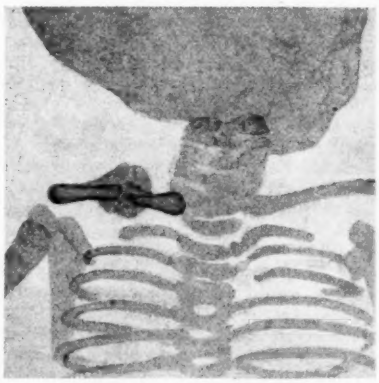

Fig. 1. Obstetrical fracture of the clavicle; roentgenogram fifteen days after birth shows exuberant callus.

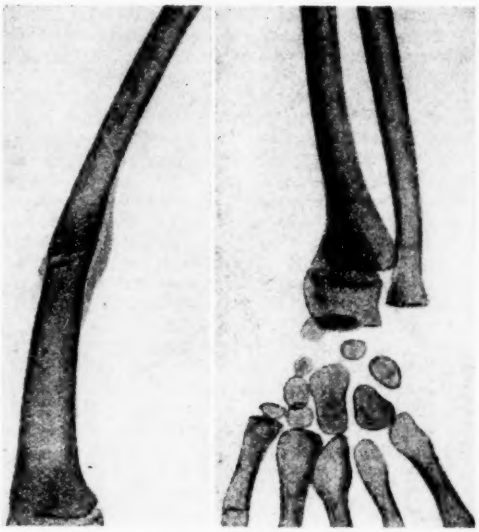

Fig. 2. Transverse fracture of the femoral diaphysis; reduction with slight angulation; heavy periosteal callus in the concavity of the angle.

Fig. 3. Transverse fracture of the metaphysis of the radius, with lateral and backward displacement of the lower fragment; roentgenogram nine weeks later shows formation of a large callus on the side of the displacement, tending to re-establish the normal axis.

With children this is different; the process of repair is not strictly localized, but is extended over the entire bone; changes take place not only at the site of the fracture, but at a distance from it, and modify the form of the bone. The entire bone participates in what may be called post-fractural reconstruction. At first the callus may seem exuberant, but as time goes on, it becomes firm where its support is needed and rarefied where it is not needed. The original shape of the bone is restored, and after several years the site of the fracture can be determined only with difficulty.

In children the periosteum is less closely adherent to the bone than in adults, and in many cases of fracture it is detached from the cortex of the bone for a considerable distance; the callus forms chiefly on the lower surface of the detached periosteum. This callus forms rapidly. The medullary callus forms late and is thinner; a clear space may persist for a long time in the line of fracture and may be mistakenly considered to indicate delayed union. However, there is no actual delay in healing of the fracture; the function is normal. The periosteal callus is formed so as to correct angulations and lateral displacements. In an illustrative case reported, that of a girl ten years of age, a transverse fracture of the diaphysis of the femur was reduced with a slight

angulation; the callus formed was much thicker in the concavity of the angle than on the opposite side, which corrected the angulation; the medullary callus was thin. If there is a fracture near the epiphysis with lateral displacement, a similar phenomenon is observed; the callus is formed on the side of the distal deviation so as to efface it.

In certain diaphyseal fractures, the periosteum may be detached only for a short distance and a small fragment may escape. In such cases the bone is repaired along its normal axis by periosteal callus formation; the fragment plays the rôle of a foreign body and is ultimately absorbed. If such a fragment is displaced backward in fractures of the elbow, it may interfere at first with the flexion of the forearm, but with the normal process of growth, the distance between it and the joint is progressively increased, so that later it does not interfere with function.

However, the natural processes of bone repair in children do not always correct the results of a faulty or incomplete reduction of a fracture. In fractures of the external condyle of the elbow, for instance, excessive bone growth on the external side of the joint may occur in spite of correct reduction of the fracture and result in deformity.

The conclusion to be drawn is that in children the form of the fractured bone may undergo modification for a long time after the union of the fracture is complete. There is, in any case, a parallelism between anatomical form and function after fracture, but in adults the function usually depends upon the form, while in children function re-establishes the desirable form. In adults restoration of normal form depends upon a perfect primary reduction of the fracture. In children the process of the reconstruction of the anatomical form is less rigid; it is less dependent on the method of reduction, and is not restricted by delay in union. ALICE M. MEYERS.

Rocugno, L.: Traumatic Dislocations of the Elbow, and Their Sequelæ in the Young (Sulle lussazioni traumatiche del gomito e i loro esiti nei giovani). *Minerva med.*, 1938, 29: 232.

The author found that dislocations of the elbow were most common in children and adolescents (75 per cent). Posterior dislocations were most frequent, occurring in 66.6 per cent of the cases. The next most common type was the posterior lateral dislocation which occurred in 13.2 per cent; lateral dislocation occurred in 8.87 per cent; isolated dislocation of the radius in 6.67 per cent; and anterior dislocation of both bones of the forearm in 4.47 per cent. Nerve complications were present in 4.4 per cent of the cases, and open reduction was necessary in 15.7 per cent of the cases.

The author is strongly opposed to early manipulation of the elbow, and believes that under no condition should it be forced, because this irritation frequently gives rise to the excessive formation of scar tissue and restricted elbow motion.

In old cases of dislocated elbow the author is in favor of leaving them alone if the arm is in a position of good function, from 80 to 90 degrees, rather than of attempting any form of open operation, as the results of late operations have been poor.

Numerous statistics from the literature are quoted, and show that elbow dislocations are second only to those of the shoulder in adults, but are the most frequent type of dislocation in infants and children.

The study of 45 cases of dislocation of the elbow is presented by the author. CARLO S. SCUDERI, M.D.

Kennedy, R. H.: The Treatment of Fractures of the Shaft of the Femur. *Ann. Surg.*, 1938, 107: 419.

The author has analyzed 120 consecutive cases of recent fractures of the shaft of the femur, treated at the Beekman Street Hospital, New York, from January 1924 to March 1932. The patients were treated by ten surgeons, and the open operative bone work was in charge of one of them only. The author believes that proper transportation of the patients, to and within the hospital, is a major factor in treatment. There were 17 early deaths in this series. In addition to the death following amputation, 2 other patients had amputations and survived. These were omitted from the study. Thus, there remained 101 patients available for more detailed analysis of their treatment. Of these, 48 were under sixteen years of age. Forty-seven received their injury as the result of motor car accidents. There were 4 compound, and 20 comminuted fractures. Seventeen fractures were in the upper third, 74 in the middle third, and 10 in the lower third of the femur. These three groups are discussed separately. The primary hospital treatment was adhesive plaster traction in a Thomas splint suspension in 43 cases, skeletal traction in 35 cases, overhead adhesive plaster traction in 11 cases, reduction and application of a plaster spica in 11 cases, and open reduction in 1 case. The initial treatment was unsatisfactory in 14 patients following adhesive plaster traction suspension, and in 2 following reduction and application of a plaster spica. The final treatment, except for complications, was skeletal traction in 43; adhesive plaster traction in a Thomas splint suspension in 31; application of a plaster spica in 12; overhead adhesive plaster traction in 11; and open reduction in 4. Traction methods were employed in 84 per cent of these patients, and in skeletal traction the tongs were removed after an average period of forty-nine days. In adults in whom traction only was used throughout the entire treatment, it was all removed after an average of seventy-five days. Among the cases treated by skeletal traction, there were 21 infections in 42 patients, 14 of these healing promptly after removal of the tongs or pin; while 7 or 17 per cent were discharged for a long enough period so that it was believed that infection of the bone was present. There were 4 early open reductions, 3 in simple fractures, and 1 in a compound fracture, all the patients being children. One had no internal fixation; a kangaroo tendon, wire, and a steel plate respectively, were used in the 3 others. The compound fracture became infected; osteomyelitis de-

veloped, but solid union occurred. The others remained clean. The incidence of open operation in children was 8 per cent. Four patients sustained refractures on the fifty-sixth, seventy-first and ninety-ninth days after injury, and 1 outside of the hospital after nine months. Three patients had late open reduction for complications. One had an open reduction with steel plating on the seventy-sixth day for a refracture on the seventy-first day. Another had a bone transplantation from the tibia on the seventy-eighth day for delayed union. The third had an internal fixation with a steel plate one year after the accident for non-union. There was 1 death during treatment, which resulted from embolism in a patient while in skeletal traction. Of the remaining 100 patients, Kennedy knows that 84 developed a solid union and 1 had non-union. The other 15 could not be followed, but the author believes there was no reason, from the position of the fragments or the progress when last seen, to expect non-union in any of these. Complete function at the knee joint was obtained in 6 cases.

As a result of this study, Kennedy concludes that by these methods of traction, bony union with relatively little shortening and good functional results may be obtained in a high percentage of cases, but he does not believe the results are good enough. Overhead adhesive plaster traction was satisfactory in children under five years of age, but skin traction was unsatisfactory in children over five years of age, with regard to recovery of the original length. Skeletal traction in adults gave too high an incidence of infection. Kennedy is still unsatisfied with Russell traction and believes that more open reductions with internal fixation should be performed, more especially in transverse fractures of the middle third and in most of those in the lower third of the femur. Although skeletal traction has given a marked improvement over reduction and application of a plaster spica or adhesive plaster traction with the Thomas splint, no single method of treatment will apply to all cases and one should be ready to employ each type of treatment according to the individual indication. EMIL C. ROBITSHEK, M.D.

ORTHOPEDICS IN GENERAL

Spink, W. W., and Keefer, C. S.: The Diagnosis, Treatment, and End-Results in Gonococcal Arthritis. *New England J. M.*, 1938, 218: 453.

This article deals with the methods of diagnosis and treatment of gonococcal arthritis and the end-results.

The diagnosis of this malady is made from: (1) a history of local gonorrheal infection; (2) the presence of gonococci in smears and cultures of urethral or cervical exudate; (3) positive gonococcal complement-fixation tests of either the blood serum or the synovial fluid; and (4) the presence of gonococci in the contents of the joints or tendon sheaths.

The patients were arbitrarily divided into three groups for this study.

Group I was comprised of 26 patients who were treated by medical means alone. This treatment consists mainly of the maintenance of the patient's general nutrition, the prevention of pain and deformity, the restoration of full function of the diseased joints by physical therapy, and the control of local genito-urinary-tract infection. Typhoid, paratyphoid, and autogenous gonococcal vaccines were used.

The average stay in the hospital of the patients in Group I was fifty days. Two patients died. Upon discharge, 18 patients or 75 per cent were completely free of all joint symptoms with no limitation of motion and with no roentgenological evidence of joint destruction. The remainder of the patients in the group had some evidence of pathological changes upon discharge.

Group II was comprised of 24 patients who had sufficient evidence of an effusion into one or more joint spaces to warrant aspiration of the synovial fluid in addition to medical therapy. One or more knee joints were aspirated in 21 of these 24 patients. The cultures of all these synovial fluids were found to be sterile.

The average stay in the hospital of the patients in Group II was fifty-three days. None of this group died. Fourteen patients or 48 per cent had complete recovery of joint function with no roentgenological evidence of joint destruction. The remainder of the patients had some temporary or permanent disability of the joints.

Group III was made up of 20 patients. The joints of these patients were aspirated, opened, and then treated by lavage. The surgical treatment was necessary either because the synovial fluid was so thick that all of it could not be aspirated through a needle or because of the presence of gonococci in the fluid. Gonococci were eradicated from the joint cavity by exposing the joint space and thoroughly washing it out with either warm saline solution or a 1 to 10,000 solution of bichloride of mercury.

The average stay in the hospital of the patients in the last group was sixty-one days. Gonococci were recovered from the synovial fluid of 15 patients, the fluid being sterile in 5. Only 3 patients or 15 per cent ultimately had no limitation of motion of the joints; the remainder had some permanent disability.

RICHARD J. BENNETT, JR., M.D.

SURGERY OF THE BLOOD AND LYMPH SYSTEMS

BLOOD VESSELS

Wilson, C., and Ogston, A. G.: The Treatment of Peripheral Vascular Disease by Intermittent Venous Occlusion. *Lancet*, 1938, 234: 606.

The authors discuss the method of Collens and Wilensky, in which intermittent venous occlusion is used in the treatment of peripheral vascular disease. They use an apparatus consisting of an electrically driven pump fitted with an alternating mechanism and timing device. The results obtained by these authors in a series of cases including thromboangiitis obliterans, arteriosclerosis, and embolism or thrombosis of a major artery to a limb appear very encouraging. In a large percentage of the cases, marked improvement was noted in the intermittent claudication, the healing of gangrenous ulcers, and the relief of rest pain.

The authors describe a new apparatus which has been devised to produce intermittent venous occlusion. It is inexpensive and may be constructed in any laboratory; and because its application is simple, it is possible for independent observers to investigate a large series of cases. Moreover, the apparatus is silent in action, and can be operated by the patient in his own home if running water is available. Venous occlusion is produced by hydraulic pressure, brought about by an automatic siphon.

The authors have used this apparatus over a period of six months in the treatment of 10 cases of peripheral vascular disease. Although their series is far too small to permit any definite conclusions, the results have been sufficiently encouraging to warrant further trial. During the treatment, all patients with intermittent claudication have shown an increased ability for walking. As Collens and Wilensky have pointed out, however, there is a tendency toward relapse after intermittent venous occlusion.

JOHN H. GARLOCK, M.D.

Kňazovický, J.: Traumatic Extravascular Aneurysms and Suture of the Peripheral Arterial System (Traumatische extravasale Aneurysmen und Suturen des peripheren Arteriensystems). *Bratislav. lek. Listy*, 1937, 17: 548.

The author examined several patients who had been operated upon because of traumatic peripheral arterial aneurysms to determine the rôle of the collateral circulation in the ultimate nutrition of the peripheral portion of the limb, and to see if, and to what extent, an accurately sutured artery is patent for the blood. Gunshot and lacerations of the radial, cubital, axillary, and posterior tibial arteries were treated by ligation of the vessel; and 2 cases of gunshot injury of the femoral artery were sutured by the Carrel-Stich method. Arteriographic examination with thorotrast revealed, surprisingly, that the artery had not again become patent at the site of suture. The form of the vascular shadow indicated that an almost complete obstruction, due to thrombus, had occurred. Following the operation, however, an extensive collateral circulation had developed (profunda femoris artery), and from this circulation a partially retrograde filling had taken place, to which the entire arterial supply of the peripheral limb was due.

The previous assumption, therefore, as to the value of circular arterial suture is erroneous. Even a perfectly sutured artery is not sufficiently patent to permit an adequate supply of blood to the peripheral tissues. No one has as yet succeeded in demonstrating the re-establishment of the lumen in a sutured major artery. The practical conclusion which the author draws from this fact is that circular vascular suture and other vascular plastics must be abandoned as valueless. Simple vascular ligature should be done instead. The rest is done by the collateral circulation, which has an astonishing capacity for overcoming the deficiency.

(IRSIGLER). LEO M. ZIMMERMAN, M.D.

Linton, R. R.: The Communicating Veins of the Lower Leg and the Operative Technique for Their Ligation. *Ann Surg.*, 1938, 107: 582.

The long and short saphenous veins connect with the deep venous systems of the leg, viz., the posterior tibial, anterior tibial, peroneal, and popliteal veins, by a series of communicating veins. In the normal state the communicating veins have valves which permit the blood to pass only from the superficial to the deep systems. In many cases of varicose veins, these valves become incompetent, and this abnormal condition often is associated with varicose ulcers. To effect a cure in such cases it is necessary to interrupt the communicating veins. Using data obtained from dissections of 10 lower legs, and on the basis of findings which he obtained in 50 operations for ligation of the communicating veins, the author presents a detailed discussion of the anatomy of these veins.

For descriptive purposes they have been divided into the posterior tibial, anterior tibial, peroneal, and popliteal groups. The posterior tibial communicating veins are found on the inner aspect of the lower leg. Usually they perforate the deep fascia posterior to the posteromedial edge of the tibia and pass forward to join the long saphenous vein over the crest of the tibia. The anterior tibial communicating veins arise from the anterior tibial veins and communicate with both the long and short saphenous systems. They extend forward on the inner aspect of the tibia in very close association to the periosteum. They perforate the deep fascia over the anteromedial surfaces of the tibia to join the long system of veins. The peroneal communicating veins arise from the peroneal veins and connect

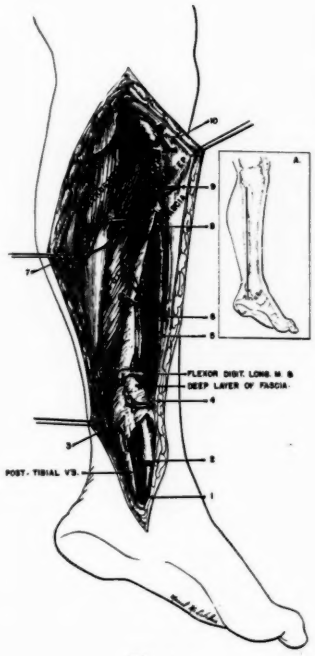

Fig. 1.

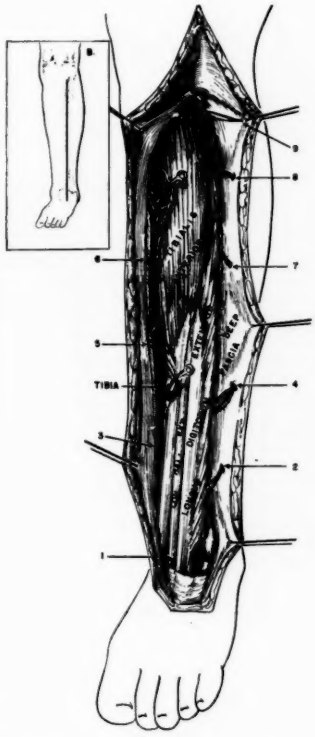

Fig. 2.

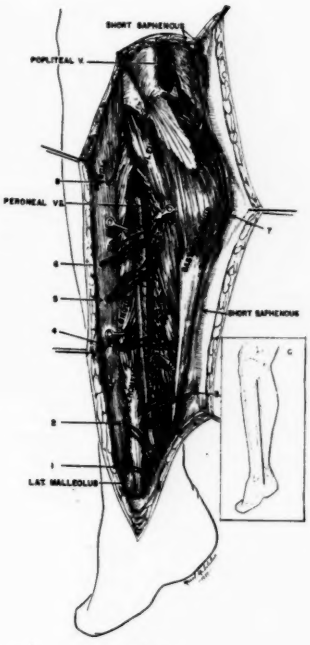

Fig. 3.

Fig. 1. A dissection of the medial aspect of the lower leg to show the medial group of communicating veins. The deep fascia has been divided longitudinally on the medial side of the lower leg posterior to the tibia, and dissected from the muscles both anteriorly and posteriorly. In the upper portion of the leg the soleus muscle has been partially divided. In the lower half the lamina profunda of the deep fascia has been cut exposing the posterior tibial artery and veins, and the flexor digitorum longus muscle. The latter muscle has been retracted to expose the medial side of the tibia. Nos. 1, 2, 3, 4, 6, 9 and 10 are posterior tibial communicating veins. Nos. 5 and 8 belong to the medial subdivision of the anterior tibial communicating veins. No. 7 represents a perforating vein which drains blood from the muscle through the deep fascia to the superficial veins. The inset shows the incision used in the operation for the ligation of these veins.

Fig. 2. A dissection of the anterior aspect of the lower leg to show the anterior group of communicating veins. The deep fascia has been divided longitudinally midway between the tibia and fibula on the anterolateral surface of the lower leg, and the anterior peroneal intermuscular septum incised to show the lateral subdivision of the anterior tibial communicating veins, Nos. 1, 2, 4, 7, 8 and 9. The tibialis anticus muscle is retracted laterally to show the central subdivision, Nos. 3, 5 and 6 on the lateral aspect of the tibia. The inset shows the incision used in the operation for the ligation of these veins.

Fig. 3. A dissection of the posterolateral aspect of the lower leg to show the lateral group of communicating veins. The deep fascia has been divided longitudinally on the posterolateral aspect of the lower leg posterior to the fibula. The dissection has been carried down along the posterior peroneal intermuscular septum to the peroneal veins and shows the peroneal communicating veins, Nos. 1, 2, 3, 4, 5, 6 and 8. Posteriorly, the deep fascia has been elevated to show the popliteal communicating vein, No. 7. The short saphenous vein is shown superficial to the deep fascia with communicating veins Nos. 3 and 7 emptying directly into it. The inset shows the incision used in the operation for the ligation of these veins.

(Courtesy of J. B. Lippincott Co.)

them with the short saphenous system on the posterolateral surface of the leg. The popliteal communicating vein is not a constant finding, but when present, arises from the popliteal vein and joins the short saphenous vein.

In order to facilitate their surgical exposure, the communicating veins have been divided into 3 main groups: the medial, the anterior, and the lateral. The operation to ligate these communicating veins should not be performed until edema and infection

have disappeared from the skin and subcutaneous tissues of the affected leg. Any ulcerations should have been healed for six weeks.

Healing of the ulceration is accomplished by placing the patient in bed and elevating the affected extremity on pillows. In many instances it will be hastened if the large ulcers are covered with large Thiersch skin grafts. After all ulcerations are healed and the infection is cleared up, a ligation of the long saphenous vein and its branches at the saphenofemoral junction is done. The short saphenous vein, if it is involved, should be ligated also at its termination with the popliteal vein.

The author presents a detailed description of the ligation of the various groups of communicating veins. All of the groups of communicating veins are rarely found to be incompetent. However, it is not unusual to find that two groups in the same leg may be affected. The medial group is the one most commonly at fault. The clinical examination will usually suffice to indicate which group of veins requires ligation. HERBERT F. THURSTON, M.D.

Homans, J.: Thrombophlebitis in Legs. *New England J. M.*, 1938, 218: 594.

The author believes that thrombophlebitis results from a combination of several factors, among which a slow current and certain anatomical relations are pre-eminent. Thrombosis takes place only in a blood current, a slow one as a rule. It is not coagulation, nor clotting, in which the formation of fibrin is the principal reaction, but rather a deposition of blood platelets, that is, thrombocytes, on the wall of a vein. After having become plastered together and fixed, these thrombocytes build out into the stream a sponge-like structure to which the white corpuscles adhere, and in whose narrow interstices clotting then occurs. This process soon occludes the vein. In its process of formation, the tail of the thrombus may extend for a long distance away from the original attachment, and it is clot-like and unsubstantial. Should it grow into a current of blood, it may become so soft and flimsy that finally it can hardly be distinguished from normal blood. This type is a potential embolus. However, the tendency of most thromboses is to stop abruptly and heal when they meet a vigorous blood current.

In the opinion of the author, most thromboses occur in the absence of severe local injury to the wall of the vein. A patient from forty-five to sixty-five years old is most liable to thrombosis, which suggests that the factor of age should be included in a consideration of causes.

Disorders of the venous return are of the greatest interest. They may be due to general circulatory failure, to cardiac weakness plus venous stasis, or to venous stasis alone. Since thrombosis occurs in a slow current, these factors are obviously fundamental. Certain sitting or reclining postures or increased abdominal tension obviously aggravate this unfavorable influence. The anatomical relations of the upper femoral and iliac veins render these vessels especially susceptible. Also in the upper calf and popliteal space there is an area somewhat like that of the groin where many currents meet. Many obscure thromboses undoubtedly originate there.

The writer comments upon the individual peculiarities of the varieties of thrombophlebitis. In phlegmasia alba dolens, femoro-iliac thrombophlebitis, or milk-leg, the obstruction commences in the upper femoral and external iliac vein. An interesting feature is the variation and severity of the initial pain. It is sometimes severe enough to suggest serious arterial ischemia. Such a state supports the hypothesis of a perivascular inflammation as the cause of the disease. A moderate fever and elevation of the pulse rate are very common. The elevation of the lower limbs above the level of the body for the purpose of drainage is essential. The affected leg should be exercised gently at the earliest possible moment. After edema has disappeared and the use of the limb is resumed, a bandage is often required for some months.

Thrombosis in the calf muscles has been little described. As a rule, the disease is very silent. The exciting cause is usually some minor injury or strain of the lower limb or foot. It is the impression of the author that this type is much more common than is generally supposed; it almost never merges into femoro-iliac thrombosis and it usually heals on proper treatment. He believes it is a relatively common source of pulmonary embolism. The unbandaged leg should be elevated on a soft pillow and after ten days exercised freely in bed. As function is gradually resumed, a semi-elastic bandage is used.

Injuries and perhaps exposure to cold seem to be exciting causes of superficial thrombophlebitis in non-varicose veins. These disappear rapidly on elevation. Fatal embolism is rare from this type.

The author has observed infarctions from thrombophlebitis in varicose veins, but no fatal embolism. If the process has reached the groin, elevation of the leg is effectual. If high division of the saphenous vein above the thrombosed area can be accomplished the immediate cure is more rapid and a recurrence is forestalled. HERBERT F. THURSTON, M.D.

BLOOD; TRANSFUSION

Durán Jordá, F., Aleu, E. M., Sardá Roca, J., Benlloch Llorach, A., Soteres Díez, F., and Others: The Study of the Metabolism of Citrated Blood Conserved *in Vitro* (Contribución al estudio del metabolismo in vitro de la sangre citratada-conservada). *Rev. de sanidad de guerra*, 1937, 1: 329, 335, 340, 344, 348, 352, 355.

Durán Jordá and Aleu find that in from sixteen to twenty days conserved blood has destroyed one and one-half million of its erythrocytes. The white blood corpuscles are diminished by half in the same length of time. The hemoglobin value remains constant. It was found that glucose-citrated blood conserved the cellular elements much longer. It is possible that part of the slight shock reaction occasionally seen

after transfusion is due to the stroma of destroyed blood cells.

Durán Jordá and Sardá Roca found that glucose added to citrated blood increases the globular resistance. In this study, as in others carried out by the transfusion service, it has been demonstrated that the addition of glucose augments the life of the various blood elements.

Durán Jordá made daily microscopic studies on the same specimen of conserved blood which showed that the leucocytes are gradually destroyed, and become an amorphous mass by the fifteenth to twentieth day. The eosinophiles are most resistant to the action of time. The lymphocytes conserve their morphology much longer than the polymorphocytes. The chief cause of the fall in the white count is the destruction of the myeloid cells. The addition of glucose does not affect the destruction of the leucocytes.

Durán Jordá and Benlloch Llorach found that by the sixth or seventh day the stored blood has lost half of its complement and by the fifteenth to twentieth day it is completely destroyed. Glucose prolongs the action of the complement and thus benefits the defensive action of the hematic alexin.

Durán Jordá and Soteres Díez state that the biological action of glucolytic ferments on the hematic glucose is a well known reaction. The Folin and Wu technique was used in these determinations. It was found that the addition of glucose to blood retards the normal phenomenon of glucolysis, and augments the life of the blood. The difficulty is the decision to add glucose to the citrated blood. Clinically it was found that 1 gm. of glucose per 1,000 gm. of blood is sufficient. Clinical experience teaches us that the renal threshold for the elimination of glucose is over 2½ gm.

Durán Jordá and Sardá Roca found that there is no noteworthy alteration in the urea content of conserved blood. It is thought that the cold completely destroys the ureolytic diastases. Glucose blood showed the same behavior.

The study on glucolysis led Durán Jordá and Villaró Closa to make a study on the other blood ferments. The electrolytic method was used in the presence of Lugol's solution. It was found that amylase disappears gradually from the blood. The presence of glucose neither retards nor accelerates this destructive process. These studies were carried out as completely original investigations without reference to the works of other investigators. The methods had to be adapted to the peculiar needs and conditions. In this original work the authors state that they did not "think with the brain of others" "no a pensar con el cerebro de los demás."

JACOB E. KLEIN, M.D.

SURGICAL TECHNIQUE

OPERATIVE SURGERY AND TECHNIQUE; POSTOPERATIVE TREATMENT

MacCollum, D. W.: The Lop Ear. *J. Am. M. Ass.*, 1938, 110:1427.

The author reports the results in 21 cases of this particular ear deformity which were seen at the Childrens Hospital of Boston, Massachusetts. Of 180,000 children admitted to this institution, 46 had deformities of the ear, and 21 cases had lop ears or bat ears.

The author believes that this deformity is definitely a congenital one, and not acquired. The external ear arises embryologically from 6 distinct tubercles. Any one or more of these primordia may fail to develop, resulting in a deformity of the ear. The fetal ridge which is to form the helix appears during the third month, and is gradually pushed upward and backward to form the outermost border of the ear. If there is a delay in development during this third month, the helix will remain in a forward position and continue its growth in a direction that is at a right angle rather than at a tangent to the head. As the infant develops, the conchal portion of the cartilage, which at birth had an abnormal forward curvature, continues to grow so that this forward curvature becomes more pronounced.

Palliative measures are completely ineffectual. As the deformity is a congenital overgrowth of the conchal cartilage it follows that to restore the ear to its normal contour the cartilage must be reduced in size. Therefore, the angle formed between the ear and the mastoid region must be reduced to at least 30 degrees. The convolutions of the cartilages must be shaped to form an antihelix and a scapha, both of which are absent in the lop ear. The skin incision must be hidden behind the ear so that it is not readily noticeable. Three methods of accomplishing these aims are described in detail.

WILLIAM C. BECK, M.D.

Master, A. M., Dack, S., and Jaffe, H. L.: Postoperative Coronary Artery Occlusion. *J. Am. M. Ass.*, 1938, 110: 1415.

The authors note that there has been little association observed between surgical operation and coronary occlusion. Between the years of 1931 and 1937, 625 attacks of coronary-artery occlusion were treated in the Mount Sinai Hospital in New York. Of these, 35, or 5.6 per cent, followed an operation in the hospital. In 13 additional cases, coronary occlusion was diagnosed by the surgeon but these were not included because no post-mortem or electrocardiographic findings confirmed such a diagnosis. In most of the cases severe pain, ordinarily associated with this condition, was absent. The condition must be especially differentiated from surgical shock and pulmonary embolism. The latter differentiation may be impossible clinically or even electrocardiographically. Two-thirds of the patients were sixty years of age or more. Men were affected about five times as frequently as women, although the operations in the hospital were about evenly distributed between men and women. In all but 3 of the cases there was evidence of moderate to severe previous coronary-artery sclerosis. Fifty-one per cent of the attacks occurred within the first three days after surgical operation. Of the remaining, 15 occurred prior to, and 2 during the third week. Although most of the operations were of major severity, it is found that coronary occlusion may follow any type of procedure, even such minor ones as paravertebral block and drainage of a phlegmon. The duration of the operation and the anesthesia did not seem to have any particular effect. The question of the use of intravenous fluids was considered, but only 10 of the patients were given fluids in this manner. The length of pre-operative bedrest did not appear to be significant.

Of the 35 patients 66 per cent died; in 5 of the patients that died the diagnosis was made only at autopsy. The authors believe that the evidence suggests that the operation precipitates the attack. The manner in which the coronary attack would be precipitated by such a procedure was considered, but no definite conclusions were reached. Surgical shock as a factor might be discounted in that it was present in 60 per cent of the cases. The authors conclude that patients over forty-five years of age should be thoroughly examined, and when coronary sclerosis is present the question of surgical intervention and the choice of surgical procedure should be given due consideration. WILLIAM C. BECK, M.D.

ANTISEPTIC SURGERY; TREATMENT OF WOUNDS AND INFECTIONS

Marcialis, I.: Staphylococcic Toxoid and Humoral Immunity (Anatossina stafilococcica ed immunità umorale). *Policlin.*, Rome, 1938, 45: sez. med. 157.

After having briefly reviewed the literature on the biological properties of staphylococcus toxin, antitoxin, and toxoid, Marcialis confirms experimentally the presence of a natural staphylococcic immunity in the child.

Previous investigators have shown that in about two-thirds of the children from two to twelve years of age, the blood serum contains appreciable amounts of staphylococcic antitoxin varying from −0.20 to 3 antitoxic units per c.cm. of serum. The titer increases during the first two years of life and reaches at about the age of seven an average level of one antitoxic unit per c.cm. of serum. About the same quantity is present in adults. Other investigators have also shown that in individuals with an active staphylococcic infection or in those convalescing

from such an infection, the staphylococcic antitoxin level in the blood is greatly increased in comparison with normal individuals.

The author divided his experimental series of cases into two groups. In the first group he used as specific antigen a purified toxoid of a minimum titer of 10 units, whereas in the second group he used a crude toxoid of the same titer. The antitoxin level in the blood serum was determined by the hemolytic method. The toxoid was administered subcutaneously every four days and the antitoxin level in the blood serum was determined before and two weeks after the last injection.

Marcialis found that in all children of his series the amount of antitoxin present in the serum was small, ranging from −0.20 to 0.50 antitoxic units per c.cm. of serum. Only in exceptional cases a titer of from 1 to 2 antitoxic units per c.cm. of serum was encountered.

Concerning the capacity of staphylococcic toxoid to increase the specific antitoxic level of the blood serum, Marcialis found that following doses of 0.20 c.cm. to 0.45 c.cm. of toxoid, the antitoxic level was increased up to about four times its original value. In one case this value was increased about ten times. In general, the author found a greater rise of the antitoxic level in children whose original titer was above 1 unit per c.cm.

The author did not observe any marked difference in immunizing activity between the purified and the crude toxoid. He found that after three injections of the crude product, the antitoxic level in the blood was almost quantitatively identical with that obtained after three injections of the purified product.

Concerning the local and general reactions of staphylococcic toxoid, Marcialis found that the purified product may give rise to severe manifestations, which are presumably due to a specific allergic state of patients with a staphylococcic infection. It is believed that patients sensitized by staphylococcic toxin react more or less violently to the specific antigens present in the anatoxic filtrate. The author recommends, therefore, to begin the injections by using small doses, especially in potentially sensitized individuals.

In general the author found that the increase of the antitoxin level in the blood serum is not directly proportional to the injected quantity of toxoid but appears to be the resultant of a complex humoral-immune reaction produced by the specific antigen.

RICHARD E. SOMMA, M.D.

Penfold, W. J., and Tolhurst, J. C.: The Prophylaxis of Gas Gangrene in Man. *Med. J. Australia*, 1938, 1: 604.

About a year ago the authors described the immunization of animals with alum-precipitated formol toxoid made from bacillus-welchii toxin. Two injections of the toxoid given subcutaneously, with an interval of four weeks, protected guinea pigs against 10 minimum lethal doses of a living bacillus-welchii culture. The serum from immunized guinea pigs was shown to have passive protective power in mice.

Stimulated by these results, the authors prepared a material apparently suitable for immunizing man against gas gangrene due to the bacillus welchii. The technique of production and administration is fully described.

It is not possible to state at the present time what level of antitoxin is fully protective, nor what is the best method of immunization, with regard to the size of the doses and the intervals between them. The duration of the immunity produced is, of course, not known as yet.

SAMUEL KAHN, M.D.

ANESTHESIA

Sise, L. F.: The Choice of Anesthesia for Surgery of the Upper Abdomen. *Am. J. Surg.*, 1938, 39: 22.

For operations in the upper part of the abdomen, as elsewhere in the body, no one type of anesthesia should be used routinely. In each case, the agent and method which are best adapted to the particular conditions should be selected. In most instances spinal anesthesia with pontocaine or nupercaine is most satisfactory. An anesthetist well skilled in the administration and management of this anesthesia is absolutely essential. When a skilled anesthetist is not available, one of the various combinations of anesthetics, usually containing gas-ether as its principal constituent, given by the intratracheal route, is very satisfactory. When an experienced anesthetist is not available, ether is of great value since it is always obtainable, is of considerable immediate safety, and produces reasonable operating conditions. Regional anesthesia is usually unsatisfactory because of its limited field, but when patients are in poor condition it becomes the best possible choice for operations such as gastrostomy and cholecystostomy. The gases used alone are too weak to be at all satisfactory. Of the gases, cyclopropane is much the best. Nitrous oxide carries with it distinct possibilities of danger because of the poor operating conditions which it produces, and because the exclusion of oxygen may be carried too far.

J. THORNWELL WITHERSPOON, M.D.

Lowenberg, K., and Zbinden, T.: Destruction of the Cerebral Cortex Following Nitrous-Oxide-Oxygen Anesthesia. *Anes. & Anal.*, 1938, 17: 101.

An increasing number of reports on fatalities following nitrous-oxide-oxygen anesthesia have been published during the last few years. The authors report 6 new cases, 4 of which were fatal; 1 patient sustained a chronic injury to the brain, and 1 recovered.

The harmful effect of nitrous-oxide-oxygen anesthesia upon the brain may be due to two factors: (1) anoxemia due to the low oxygen content of the blood, and (2) the toxic effect of the gas.

Clinical and experimental observations do not support the view that anoxemia is the responsible fatal factor. The pathologico-anatomical findings

point clearly toward the cause of the destruction of the brain tissue. These changes consist in a pronounced swelling of the brain as described by Reichardt. According to him, brain swelling is an increase in the volume of the brain not produced by hyperemia or the accumulation of free fluid between the tissue structures, such as edema, meningeal hydrops, and hydrocephalus, or by tumors or inflammatory conditions, but is caused by the retention of water by the cells and glial structures. Nitrous oxide is, therefore, probably capable of directly influencing the metabolism of the nervous tissue and thereby causing the retention of water in its structures.

The destruction of the cerebrum due to nitrous oxide is never focal, but is either laminar or diffuse. In patients surviving sixty hours, the laminar type is predominant; in patients dying during the anesthesia or from six to eight hours after it, the changes are diffuse, affecting with equal severity the neurones in all layers of the cortex. SAMUEL KAHN, M.D.

Burford, G. E.: Pulmonary Complications After Cyclopropane. *J. Am. M. Ass.*, 1938, 110: 1087.

The factors concerned in the production of postoperative pulmonary complications are: (1) the anesthetic agent, including the technique of administration and recovery; (2) the site of the operative procedure; (3) the duration of the operation; (4) the sex of the patient; (5) the pre-operative condition of the patient; and (6) the depth of the anesthesia.

Burford reports on cyclopropane and its action on 1,333 patients in his own practice. Thirteen (0.97 per cent) of the patients developed pulmonary complications. The advantage of this anesthetic lies in its rapid elimination (hypoventilation consideration) and the reduced irritation in the respiratory tract (obstruction consideration). The routine administration of cyclopropane at St. Luke's Hospital in New York involved the regular addition of inert gas, chiefly helium, to the anesthetic mixture. The value of this technique lies in the prolonging of the absorption time of the gases in the hypoventilated or even completely static portion of the lung.

The important factor with regard to the operative procedure is the increased depth of the anesthesia that necessarily accompanies operation on abdominal areas.

The duration of operation in the 13 complicated cases in this series was an average of one hour and thirty-eight minutes. In only 1 of the 13 cases did complications develop after an operation lasting less than one hour.

There is no doubt that males show a greater predisposition to pulmonary complications than females. It is also true that the administration of anesthetics to males is more difficult than to females. The metabolism in the male tissue is more active, and produces on the average 40 calories per sq. m. of body surface per hour, as compared with 37 calories for female tissue. Muscular action, when once initiated, is much more intense in males. This results in subsequent derangement in the anesthetic atmosphere through losses and subsequent additions of the anesthetic, and produces a too high concentration. This, in turn, leads to an uneven, irregular induction. A heavily, properly premedicated male is thought to be about equally as difficult as the average female. The author proposes to increase the preliminary medication of males enough to bring them to the operating room almost asleep, with metabolic rates greatly depressed, and as nearly as possible insusceptible to the stimuli of their surroundings, the medication being given far enough ahead (for instance, one and one-half hours for morphine) to have reached its maximum effect before the anesthesia is started, and to be wearing off as the anesthesia progresses. He further proposes to use cyclopropane, the rapid induction of which, when desired, takes effect with a minimal amount of stimulation, muscular activity, and subsequent metabolic elevation.

It has long been observed that elderly, debilitated, septic, or acutely ill patients are more prone to postoperative complications. In this series, however, no marked confirmation of these facts was apparent.

With regard to the depth of anesthesia, the contrast in this series between the incidence of pulmonary complications developing after abdominal operations, and after non-abdominal operations is interesting. There were 626 abdominal operations with pulmonary complications in 2.07 per cent, and 707 non-abdominal operations with no postoperative pulmonary complications. J. DANIEL WILLEMS, M.D.

Ashworth, H. K.: Basal Anesthesia. *Practitioner* 1938, 140: 232.

Basal anesthesia aims at the comfortable production of unconsciousness and a sufficient depth of narcosis to enable subsequent surgical anesthesia to be obtained and maintained by the superimposition of nitrous oxide and oxygen, or a small amount of ether or chloroform. No basal anesthetic should be used in doses sufficiently large to produce full surgical anesthesia without the need of any additional inhalational or other anesthetic.

The advantages of basal anesthesia are:

1. It has a beneficial psychic effect on the patient; pre-anesthetic apprehension is minimized.

2. Full surgical anesthesia can be maintained, often with the use of gas and oxygen alone. If ether or chloroform is necessary, small amounts usually suffice.

3. The postoperative period is one of greater comfort and well-being for the patient.

4. The patient is not subjected to the harmful biochemical changes produced by the administration of ether or chloroform in large quantity or to the strain thrown upon the liver and kidneys in excreting the drugs.

5. Postoperative vomiting is usually slight.

6. Postoperative respiratory complications are reduced.

The disadvantages of basal anesthesia are:

1. The use of basal anesthesia involves the spending of a considerably longer period of time by the anesthetist on each case, and a long period of nursing care after the operation.

2. The administration of the superimposed inhalation anesthetic is rendered more difficult by the previous administration of the basal anesthetic.

3. A basal anesthetic, once administered, is uncontrollable.

The drugs used for the production of basal anesthesia fall into three main groups: (1) avertin, (2) paraldehyde, and (3) barbiturates. The methods of administration, advantages, and contra-indications of each are discussed. SAMUEL KAHN, M.D.

Binet, L., and Strumza, M. V.: The Sensitivity to Anoxemia in General Anesthesia (De la sensibilité à l'anoxémie au cours l'anesthésie générale). *Anes. et Anal.*, 1938, 4: 41.

Binet and Strumza report experiments on dogs to determine whether there is increased sensitivity to lack of oxygen in subjects under anesthesia. If such increased sensitivity exists, it indicates the need of supplying oxygen to patients when anesthetized.

In previous experiments with dogs anesthetized with chloralose given by injection and subjected to atmospheres low in oxygen, the authors found that respiration was arrested at atmospheric pressures corresponding to an altitude of 11,000 meters, or 4.69 per cent oxygen, shortly after the injection of chloralose. However, two hours or more after the injection, the animals could withstand atmospheres corresponding to altitudes of 13,000 meters and more, or 3.39 per cent and less of oxygen. In more recent experiments, it was found that dogs subjected to inspiration of an atmosphere corresponding to 13,000 meters, 3.39 per cent oxygen, ceased to breathe within a few minutes an hour or two after being anesthetized, but could be revived by the inhalation of oxygen. However, several hours later, when the chloralose was largely excreted, these animals were much more resistant to the diminished supply of oxygen. Repeated tests as the animals were recovering from the effect of the anesthetic showed that their resistance to the low oxygen content of the inspired air increased rapidly. However, if another small dose of chloralose was given, the respiration became slower and of diminished amplitude, and the resistance to the anoxemia again diminished.

In further experiments it was found that after section of the vagus nerve, the response of the animals under anesthesia to anoxemia was the same as in normal animals; and these animals showed the same increased resistance to anoxemia as the effect of the anesthetic wore off. This indicates that general anesthesia has a direct action on the respiratory center, rendering it less resistant to the effect of anesthesia.

In the discussion of this report, CORDIER states that his experiments with chloralose had given the same results as those of Binet; but that experiments reported by others, with anesthesia produced by the injection of the barbiturates, showed that with these drugs respiration is maintained by a reflex excitation of the respiratory center by the resulting anoxemia, and the administration of oxygen has an unfavorable, rather than a favorable effect on the respiration.

ALICE M. MEYERS.

Woodbridge, P. D.: Important Minor Points in Local Anesthesia. *Canadian M. Ass. J.*, 1938, 38: 216.

As a foundation for a successful local anesthesia, the patient should be effectively narcotized. Morphine, or some other dependable pain relieving drug should be given in doses that are rather liberal as compared with those ordinarily used before spinal, ether, or cyclopropane anesthesia. On the other hand, the doses of drugs used to allay apprehension, such as scopolamine and the barbiturates, should be small. The doses of all drugs should be increased above the average for the youthful patient, for the unusually muscular and vigorous, and for those afflicted with fear, fever, or thyroid toxicity. The doses of drugs used should be decreased if the metabolic rate and reflex activity are low. This occurs in infancy and old age, in the presence of anemia, myxedema, prolonged invalidism, or weakness from any cause.

Metycaine seems to be superior to procaine (novocaine, neocaine), in that the anesthesia develops more rapidly, is more intense, and lasts longer. Furthermore, its toxicity clinically appears to be no greater than that of procaine. One-half per cent and occasionally 1 per cent solutions of either procaine or metycaine are used for local infiltration and field blocks. The solvent should be physiological saline solution. The solution should be warmed to body temperature.

One should differentiate between the toxic effects of the local anesthetic, on the one hand, and of the vasoconstrictor drug used, on the other. The gradual absorption of the local anesthetic causes a drop in the blood pressure, pallor and sweating, and, in severe cases, nausea, vomiting, and respiratory depression. The undesirable effects produced by epinephrine are different from the foregoing. A subjective sense of fear is probably the first effect to develop. Objectively, there develop a rise in the blood pressure and pulse rate, pallor, and a fibrillary tremor of the skeletal muscles. A feeling of constriction around the chest may be present. Further injection should be delayed until these signs and symptoms have subsided. This usually occurs in from twelve to fifteen minutes. It is likely that most cases of toxicity from local anesthesia are in reality not from the anesthetic drug but from excessive amounts of epinephrine in the solution. The toxicities of local anesthetics and of vasoconstrictor drugs are largely antagonistic. A careful balancing of the dosage might, therefore, balance the antagonistic actions. The amount that has proved satis-

factory is 0.2 mgm. of epinephrine, or 0.2 c.cm. of a 1 to 1,000 solution, for each gram of the anesthetic drug. One gram of the anesthetic is the amount contained in 100 c.cm. of a 1 per cent solution. This proportion corresponds roughly to one minim per ounce of a 1 per cent solution.

It is evident that no dogmatic answer can be given to the question as to the total amount of solution that can be safely used. The anesthetist should always be on the lookout for signs of toxicity and should not inject more than 80 c.cm. of a 1 per cent solution without a pause of ten minutes to allow signs of toxicity to develop.

The syringe should be of glass so that aspirated blood can be seen. A capacity of 10 c.cm. is convenient. The nipple should be excentric so that needles may lie immediately beneath the skin throughout their full length without being bent.

There are several points of technique that are often neglected in the many types of injection:

If skin wheals are to be made less painfully, the needle should be held with the bevel facing down rather than up.

The forefinger of the left hand serves as a very helpful guide during subcutaneous injection. It palpates the skin just ahead of the point of the needle, senses just how deep the point is, and depresses either the point of the needle or the skin ahead of the needle to keep the point at just the right depth.

To avoid intravascular injection of a considerable amount of solution, either the needle should be kept moving or frequent aspiration should be made. Not more than 1 c.cm. of a 1 per cent solution should be injected with the needle stationary unless the aspiration test is performed.

As a precaution against breaking needles, they should not be curved but should be kept straight whenever possible. For subcutaneous injection in a concave area the skin should be pulled up into a straight line so as to conform to the straight shaft of the needle.

For field-block of superficial lesions, an equilateral quadrangle of subcutaneous injections may be made around the lesion, and the needle may then be inserted through the wheal at each corner of the quadrangle and slanted towards a point directly underneath the center of the lesion. In this way a cone-shaped wall of solution may be deposited under and around the lesion.

For abdominal field-block the location of the wall of anesthetic solution will depend on the site of the proposed incision.

Honesty must be the rule in deciding whether an injection has really produced anesthesia. When anesthesia does not follow the injection of the solution, other methods should be employed. The best local anesthesia may be rendered futile if the surgeon uses a technique adapted only to spinal or deep general anesthesia. Only those surgeons who are willing to adopt the necessary gentleness and nicety of technique that is required by local anesthesia should attempt to work with it.

SAMUEL KAHN, M.D.

X-RAY TREATMENT OF INFECTIONS

Collective Review

M. LOWRY ALLEN, M.D., Philadelphia, Pennsylvania

WITHIN the past few years the value of roentgen therapy in the treatment of acute and chronic infections has been thoroughly proved and established. At present it is recognized as a potent ally of the physician and surgeon in the successful management of various types of inflammatory conditions. Despite the experimental observations of Schaefer (26), Motojima (19), and Lacassagne and Vinzent (13), and the clinical testimony of Coyle (1), Dunham (4), Ross (25), Hodges (7), Heidenhain and Fried (6), Pordes (21), Manges (17), and many others, this mode of therapy has not been accorded the widespread use which the treatment merits. This is due to several factors, among which may be cited the skepticism of the profession as to the curative value of a mode of therapy which has claimed to be effective in a multiplicity of infectious states; the disbelief aroused by the varied explanations of the favorable mode of action of irradiation on inflammatory lesions; the fear that its use might result in permanent skin damage; and the rather generalized lack of knowledge among physicians regarding the favorable action of irradiation on acute and chronic infections.

The first use of roentgen rays in the treatment of inflammatory processes goes back to 1902 when it was observed that certain types of infections seemed to improve following the exposure of the affected part to roentgen rays for purposes of diagnosis. This observation prompted the idea, long since discarded, that the roentgen rays possessed distinct bactericidal properties. Then followed numerous and exhaustive studies of the action of the rays on living tissues and cellular elements, which resulted in the present well-grounded concept of the mechanism through which irradiation operates in various pathological states.

Desjardins (3), in a comprehensive explanation of the mechanism by which irradiation operates in cases of acute and chronic infection, says, "Anyone who has had extended experience with radiotherapy for acute inflammations cannot fail to have been impressed by the prompt relief of pain and rapid resolution of lesions when treated early, or acceleration of suppuration in lesions treated later; by the fact that acute inflammations of various kinds respond at about the same rate to a given dose when treated at a corresponding stage; and by the fact that a small dose of rays is sufficient to produce this effect." He argues that since irradiation acts in the same way and on so many forms of acute inflammations, it would seem logical to conclude that the lesions themselves must have some common factor. This factor would seem to be the radiosensitiveness of certain cells which is more or less a prominent feature of the majority of the acute inflammations. In considering pyogenic infections Desjardins points out that these in general are characterized by varying degrees of leucocytic infiltration: leucocytes, chiefly lymphocytes, polymorphonuclear cells, and eosinophils accumulating around one or more clusters of bacteria. This leucocytic regimentation appears to be nature's method of intensifying the production of antibodies. Hyperemia is an additional factor which facilitates the mobilization and regimentation of the leucocytes. In certain acute inflammations, particularly those caused by streptococci, local leucocytic infiltration is not a prominent feature. Against infections of this kind the body apparently defends itself by a general reaction of the leucocytes in the circulating blood. Experiments on animals and human beings have shown that each type of cell has a specific degree of sensitiveness to irradiation, some being extremely sensitive to small doses, while others are not influenced by doses many times larger. The most sensitive of all the cells are manifested in the spleen, lymph nodes, lymph follicles, thymus gland, circulating blood, and bone marrow. The polymorphonuclear and eosinophil leucocytes are also sensitive but their susceptibility to irradiation is less than that of lymphocytes. Warthin (28) found experimentally that lymphocytes were destroyed in fifteen minutes following irradiation.

In circumscribed inflammations the rays act mainly by destroying a portion of the lymphocytes infiltrating the lesion or circulating in the blood vessels which supply the affected area. This disintegration of the infiltrating leucocytes results in the liberation of the antibodies, ferments, and other protective substances contained in these

cells. These liberated substances become mixed with the tissue fluids in the surrounding tissue spaces. The protective substances thus liberated are more readily available for defensive purposes than when contained in the original intact white blood cells. At the same time there is an increase in phagocytosis by the reticular cells, which become macrophages. This cellular destruction and increased phagocytosis represent the effect on the body to exposure to the roentgen rays in localized pyogenic infections and probably explains the universal favorable action of these agents. This view is further supported by the clinical circumstances which indicate that inflammatory lesions respond to irradiation in proportion to the degree of leucocytic infiltration. Other supportive evidence is the fact that radiotherapy is most beneficial during the infiltrative stage of such infections and less beneficial during the suppurative stage. That there is a variation in the degree of leucocytic infiltration of different lesions of the same character or of similar lesions of different character is a well known pathological fact and probably explains why some lesions respond more readily to irradiation than others. In inflammations that are not circumscribed and in which leucocytic infiltration is comparatively slight, the affected area is hyperemic and the vessels are more or less engorged with blood. Wide exposure of such an area to small doses of irradiation undoubtedly causes the disintegration of many leucocytes and the contents of the destroyed cells are liberated into the blood and throughout the tissue spaces. This makes possible a biological defensive reaction similar to that described in more limited inflammations.

In discussing the effects of irradiation on chronic inflammations Desjardins points out that such lesions are characterized by varying degrees of leucocytic infiltration, connective-tissue proliferation, and caseous or calcareous degeneration. In view of this fact the clinical effect of irradiation in such conditions is slow, and maximal improvement or cure is obtained only after repeated treatments at varying intervals. While the leucocytic infiltration in such chronic lesions is readily susceptible to destruction or diminution from exposure to the roentgen rays, the connective-tissue elements are comparatively resistant to such exposure. Hence, the greater the degree of leucocytic infiltration in proportion to the connective-tissue proliferation, the more marked and more rapid is the influence of the treatment. This is well exemplified in the treatment of tuberculous lesions in which it has been found that the effect of irradiation is greater during the infiltrative phase of the tubercles, when leucocytic infiltration is most pronounced, than it is when the leucocytic infiltration has diminished and the lesion has passed into the advanced stage of caseous degeneration or repair with connective tissue or by calcification. This conclusion is in complete agreement with the experimental evidence and all of the clinical observations that have been recorded.

Hodges and Berger (10), citing their experiences and observations in the irradiation therapy of infections over a period of seventeen years, have classified the lesions into two groups in accordance with the susceptibility to irradiation. Group 1 comprises early localized erysipelas in adults, furuncles and furunculosis, granulomas, infected hemangiomas, cellulitis of certain types, lymphangitis of certain types, Mikulicz's disease, parotitis, and rhinophyma. Group 2 comprises carbuncles, blastomycoces, and sporotrichosis. The writers feel that all of the infections listed in Group 1 are amenable to x-ray therapy to such a degree that no other form of therapeusis is necessary in their treatment. The lesions listed in Group 2, however, are of such a nature that irradiation is the important auxiliary in the management of these conditions. In the treatment of erysipelas, particularly the early localized form in adults, irradiation therapy may be considered as a specific. Small early lesions so treated disappear within twenty-four hours, and require no further therapy. The temperature and toxicity in such cases are rapidly alleviated and the edema and erythema quickly subside, and leave a wrinkled and exfoliated skin in from thirty-six to forty-eight hours. The dose required is from 100 to 150 roentgen units (measured in air) of unfiltered irradiation with a voltage of approximately 85 kv. This dose should be administered well beyond the apparent borders of the lesion in order to prevent further streptococcic permeation of the corium. Furuncles and furunculosis likewise respond favorably to irradiation therapy. If treated early such lesions may be completely aborted in from twelve to twenty-four hours following the administration of a small dose of unfiltered rays. If more advanced lesions are similarly treated suppuration will be hastened. Chronic furunculosis, in which the pathological condition extends deeper into the skin with more connective-tissue involvement, is best treated by the use of more heavily filtered rays. The dose in such cases is 125 roentgen units, filtered through 6 mm. of aluminum, with 125 kv. and it is repeated several times at weekly intervals. Infected angiomas and granulomas, with their abundant overgrowth of vascular

and cellular tissue, respond well to doses of from 700 to 900 roentgen units of unfiltered irradiation. Following this the lesions gradually regress and disappear in from two to four weeks. Cellulitis and lymphangitis of certain types are particularly amenable to small doses of from 100 to 150 roentgen units of unfiltered rays. In Mikulicz's disease larger doses than ordinarily required by other inflammatory processes are given owing to the production of connective tissue and the lymphocytic infiltration characterizing this condition. The most effective dose consists of 400 roentgen units with 200 kv., and a filtration of 1 mm. of copper and 1 mm. of aluminum. Postoperative parotitis, which normally has a mortality rate of from 35 to 60 per cent, may show a markedly lowered rate if the irradiation therapy is given early. At the same time the percentage of such cases going on to suppuration is markedly decreased. In infected rhinophyma, roentgen therapy is the treatment of choice because of the pathological nature of the lesion which makes it difficult to treat it by any other method. Such lesions usually respond to a dose of 300 roentgen units of filtered rays. There is a prompt regression of the lesion and the final result is a nose of normal appearance, exhibiting little or no telangiectatic elements and a smooth, natural skin.

In the roentgen treatment of carbuncles, which the authors classify in Group 2, surgical and other measures are usually also required. Irradiation alone in these cases usually limits the spread of the infection, shortens the course of the disease, and probably lowers the mortality. If treated early, carbuncles can often be completely aborted following a single treatment. In the later stages, repeated treatments with small doses of unfiltered rays may be necessary. Blastomycosis and sporotrichosis respond favorably to irradiation. These are best treated by the application of from 500 to 700 roentgen units of filtered rays. Irradiation in these cases is supplemented by iodine therapy. Every infection, whether it appears trivial and unimportant or localized and delimited in the beginning, is a harbinger of potential sequelæ such as thrombophlebitis, lymphangitis, and pyemia. Irradiation plays an important rôle in the prevention of the development of these complicating factors. Each case of infection should be individualized and treated accordingly. The interval between treatments is determined by the reaction of the lesion. Hot dressings, if employed in conjunction with roentgen therapy, should be confined merely to the site of the lesion and not applied to the surrounding tissues. General supportive measures should also be utilized in the successful management of these conditions, and the close co-operation of the radiologist, surgeon, and internist should prevail at all times.

Manges (17) speaks of the value of roentgen therapy in the treatment of furuncles, carbuncles (especially those of the face), paronychia, felon, abscess, erysipelas, cellulitis, lymphangitis, pelvic infection in the female, cystitis, periproctitis, parotitis, acute sinus and mastoid infection, gas bacillus infection, postoperative wound inflammations and infections, unresolved pneumonia, and lobar pneumonia when treated early. The optimum time for the treatment of these conditions is when the first definite evidence of infection is established with pain, swelling, redness, tenderness, fever, leucocytosis, lymphangitis, and adenitis. In other words, the inflammatory process must be established before irradiation is effective. If the treatment is given in this early stage of such infections, a large percentage of the suppurative lesions disappear without going on to suppuration. One of the most remarkable clinical observations is that many of the most toxic patients, following treatment with roentgen therapy, experience a real sense of relief with a prompt amelioration of many of the symptoms. If treatment is given after localized infections go on to suppuration, the latter process is accelerated, which results in better localization and prompt pointing of the suppuration. Some of the rules covering irradiation therapy are: the treatment should be limited to the area of disease; the dose in acute stages, with a few exceptions in the later stages of superficial infections, should never exceed from 10 to 20 per cent of a skin erythema dose, or from 60 to 120 roentgen units; relatively low voltage of from 80 to 135 kv. should be employed with unfiltered or light filtration; deeper lesions, such as felons and carbuncles, require higher filtration, up to 4 mm. of aluminum. With deep-seated or massive lesions, deep therapy is employed with a voltage of 200 kv. and a filtration of ½ mm. of copper and 1 mm. of aluminum. The dosage of such cases should be limited to from 10 to 20 per cent of a skin erythema dose.

Hodges (9) states that one of the most useful applications of the roentgen ray in the treatment of potentially serious infections is in the treatment of those apparently more or less insignificant lesions which occur on the upper lip, around or within the nose, around the eyes, and to a lesser extent on the extremities. In these cases the primary portal of entry is frequently no more than a slight abrasion, a cut, a bruise, or a pimple. If the infection in such cases is of sufficient virulence there is a rapid lymphangitis and thrombo-

phlebitis, and if the infection is not halted a fatal sinus thrombosis or other intracranial complication frequently results. These facial lesions should be submitted to x-ray therapy as early as possible in order to prevent the occurrence of the foregoing complications. A small dose of from 100 to 150 roentgen units of unfiltered, low voltage rays should be applied. This causes a rapid walling-off of the infection within a few hours. In infections of this type, which are due to the hemolytic streptococcus, antistreptococcic serum and blood transfusions from an immunized donor should be employed. Insignificant and potentially serious infections of this nature which occur on the extremities, particularly the feet, should also be submitted early to irradiation therapy, owing to the liability of such infections to cause a generalized septicemia.

Knupfer and Hummel (12) report their treatment of 49 cases of postoperative parotitis with irradiation therapy. As controls the records of 21 cases treated in the usual manner without irradiation were used for comparison. The factors used were 190 kv.; 3.5 ma; 0.5 mm. of copper plus 3 mm. of aluminum filter, with a dosage of from 150 to 200 roentgen units. This amount of treatment was repeated once or twice at two-day intervals. Most favorable results were obtained in those cases treated early after the appearance of the parotitis. The later the application of the irradiation, the more often was it impossible to avoid the need for surgical intervention. However, favorable results were obtained in those cases in which suppurative softening supervened. In most all of the irradiated cases the patients experienced a reduction in temperature and a general improvement in their clinical condition. At the same time it was noted that the hospital stay was shorter in the irradiated group of patients than in those treated with the usual methods.

Robinson and Spencer (24) treated 12 patients with postoperative parotitis with irradiation, using highly filtered, high voltage rays. Three hundred roentgen units were administered at one sitting to the involved side, or, if the process was bilateral, to both sides. The parotitis in all of these cases occurred following laparotomy. There were 3 deaths in the series of cases treated, which represent a distinct decrease in the mortality generally encountered in these cases when ordinary methods of treatment are used. When irradiation is given early in postoperative parotitis the inflammatory process is aborted or results in early localization.

Kelly and Dowell (11) report the results of irradiation therapy in the treatment of 56 cases of gas gangrene. In 44 of these cases the infection was confined to an extremity. The mortality rate in this series of cases was 8.9 per cent, which figure compares favorably with any series of cases of gas-bacillus infection so far reported in the literature. The technique of treatment recommended by the authors is the wide exposure of the affected part to the rays twice daily until there is a distinct regression of the lesion. One hundred roentgen units are given at each treatment over each area with a filtration of 1 mm. of aluminum, if the infection is confined to an extremity, and heavier filtration and higher voltage, if the process involves the trunk. Amputation seems to be an unnecessary therapeutic procedure, as there were 12 patients who did not undergo amputation and all of them recovered. Despite the efficacy of irradiation in this series of cases, the use of serum should not be abandoned; however, some of these cases received no serum therapy. The use of tetanus antitoxin is likewise advocated. The best results were obtained when the irradiation therapy was instituted early.

Margraf (18) treated 118 cases of puerperal mastitis with irradiation therapy and compared the results obtained with the results in a series of 127 cases which were treated with more conservative methods. The technique used consisted in the employment of rays generated at 172 kv., using 4 ma. and filtered through 0.5 mm. of copper and 1 mm. of aluminum; a dose of 115 roentgen units of such rays was given over the affected breast. If pain and fever did not properly disappear a second treatment was given after forty-eight hours, followed by a third treatment if necessary after ninety-six hours. Before treatment the breast was pumped empty and afterward elevated by bandages; wet alcohol dressings were occasionally used. Direct nursing of the breast was not permitted during the course of roentgen therapy. When only one or two irradiation treatments were needed, the inflammatory process quickly resolved in 61 per cent of the cases, while 33 per cent of the cases requiring three treatments showed resolution. The best results were obtained when the roentgen therapy was instituted early in the course of the disease or with the first appearance of pain, swelling, fever, and leucocytosis. Of 71 cases in which the treatment was started within twenty-four hours, 92 per cent had spontaneous healing, as compared with 71 per cent of the 127 non-irradiated cases and with 81 per cent of the cases in which irradiation therapy was started after the lapse of twenty-four hours. If surgical measures became necessary, irradiation did not seem to shorten the duration

of the disease. In the cases successfully treated with irradiation, lactation soon returned to normal and was fully preserved during the entire lactation period.

Powell (22) reports on the treatment of 47 cases of lobar pneumonia with irradiation therapy. Treatment in these patients was started in all stages of the disease and without regard to the type of the causative organism. None of the patients received serum therapy, although the customary routine supportive treatment was given in addition to the irradiation. The factors used were 130 kv. with a filtration of 3 mm. of aluminum, and 250 roentgen units were given at one time over the involved lung. When the patients did not respond to such treatment a second dose was given within from twenty-four to forty-eight hours. Comparing the results obtained in this series of cases with the results in a series of 76 patients treated without irradiation, the author made the observations that the irradiated patients seemed to be made more comfortable; many had their crises during the twenty-four hours following their first irradiation; a larger percentage of the irradiated patients recovered by lysis than did those treated by other methods; a lowered mortality rate obtained in those receiving irradiation therapy, and complications were fewer in this group of patients. The early crisis following irradiation is thought to be due to the destruction of the lymphocytic infiltration in the affected lung, which releases a specific lysin and causes a rapid solution of the coagulin, which is the principal component of the pneumonic consolidation.

Feinstein and Poppe (5) treated 30 patients with lung abscess with irradiation therapy. In 17 of these patients the condition developed following pneumonia and in 10 after influenza. Twenty-five of the cases were uncomplicated by gangrene. Recovery occurred in 22 of the 25 uncomplicated cases, while improvement was noted in the other 3. None of the 25 patients developed any sort of a complication or relapse. Following irradiation, improvement in the patient's general condition was usually noted, sometimes as early as after the first treatment. The factors employed were 150 kv.; 3 ma; 0.5 mm. of copper plus 1 mm. of aluminum filter, and 30 cm. skin target distance, and from 20 to 25 per cent of a skin erythema dose was given at one sitting. No patient received more than a total of 5 treatments. The authors believe that roentgen therapy yields the highest percentage of cures and the most lasting results in recent cases of lung abscess as compared with all other methods of treatment. In chronic lung abscess the results obtained from roentgen-ray therapy were good also, but the irradiation must be repeated.

Lattman (14) employed roentgen therapy in the treatment of 20 cases of subacromial bursitis. In 15 of the patients the pain was relieved from twenty-four to forty-eight hours after the first treatment, and there was also a marked increase in the motion of the arm in each case. The treatment given consisted in the application of 350 roentgen units, using the following factors: 200 kv.; 0.25 mm. of copper filter; 50 cm. skin target distance; and one anterior and one posterior field over the affected shoulder. In most cases only one treatment was necessary to relieve the patient completely of pain and restore freedom of motion. The author believes that irradiation treatment enables the patient to resume his normal routine more quickly than any other form of treatment in this disabling condition.

Schenck (27) administered irradiation therapy to 105 children suffering from acute cervical adenitis. Of these patients 85.7 per cent were cured without ensuing suppuration, while in the remaining 14.3 per cent the glandular lesion terminated in pus formation. In all but 5 of the patients the adenitis was secondary to an infection of the upper respiratory tract. In the patients who were classed as cured, all subjective symptoms were relieved in forty-eight hours and the temperature returned to normal, while the glandular swelling subsided within one week. The earlier the treatment was given in the course of the disease, the better the response to the roentgen therapy. The dosage used consisted of from 10 to 20 per cent of a skin erythema dose, the treatment being administered at intervals of every other day until a favorable response was secured. Schenck expressed the belief that roentgen therapy is the treatment of choice for acute cervical adenitis and should be so recognized.

Pfahler and Kapo (20) analyzed the results obtained from the roentgen treatment of 333 cases of acute and chronic cervical adenitis. In 133 of these cases a clinical diagnosis of tuberculosis was made. In 22 the diagnosis was confirmed by biopsy. Of the total number of patients 184 were females and 149 males. The youngest patient treated was two weeks of age and the oldest sixty years. One hundred and fifty-nine of the 333 patients returned for observation, from which it was shown that 152 patients were cured or partially cured while only 7 patients did not show improvement. The factors used in the treatment of these patients were as follows: 130 kv.; 5 ma., 40 cm. skin target distance; 6 mm. of aluminum

filter; and a dosage of 300 roentgen units which was administered at intervals of from one to two weeks until the desired results were obtained. No more than 10 treatments were given to any 1 patient, while the average number of treatments given was from 2 to 4. Those patients with old sinuses and scars resulting from previous attacks of the adenitis were treated by electrothermic destruction followed by irradiation. The authors warn against the production of atrophy and telangiectasis of the skin over the treated areas when too large doses are applied or when the total dosage employed exceeds the known margin of safety.

Rathbone (23) cites his results in treating 70 cases of sinus disease in children with roentgen therapy. All of these patients had roentgen examination of their sinuses before and after treatment and were followed over a period of from one to three and one-half years. In this group 57 per cent were cured, 28 per cent showed improvement, and 15 per cent were not benefited by the treatment. The criterion of cure was a complete disappearance of all evidence of sinus disease from a clinical and roentgen standpoint. The patients receiving the most benefit from roentgen therapy were the children with a diffuse lymphoid hyperplasia throughout the nose and throat, accompanied with a watery or mucous nasal discharge, a history of frequent colds, a chronic cough, and a roentgen demonstration of hyperplasia of the mucous-membrane lining of the antra or ethmoids. After roentgen therapy it was found that these children had fewer colds and the sinuses were rarely ever again involved. Two techniques were employed in the treatment of this series of patients; one consisted of a peak voltage of 125 kv.; 5 ma.; 12 inches skin target distance; 5 mm. of aluminum filtration, and a dose of 120 roentgens (measured in air). The other technique consisted of a peak voltage of 220 kv., 20 ma., 50 cm. skin target distance, 0.15 mm. of copper filtration, and a dose of 100 roentgens (measured in air). Three fields were used, one anterior, and a right and left lateral. The eyes and eyebrows were protected with lead shields. A total of 6 treatments was the usual routine, the treatments being given 3 times a week over a two-week period. Such treatment was found to be absolutely harmless and without any immediate or late ill effects.

Daniel (2) reports good results from the irradiation treatment of early cases of acute otitis media, resolution of the process occurring without suppuration when the treatment was applied within the first twenty-four hours. A dosage of from 20 to 50 roentgen units was applied over the affected ear. When suppuration has occurred, irradiation should be used with caution except when surgical drainage is provided. Similar good results were obtained following irradiation in early cases of acute sinusitis and mastoiditis.

Lucinian (16) in his office practice treated 50 consecutive cases of otitis media with irradiation therapy. Thirty-one of the patients were in the acute stage of the disease, 8 were in the subacute stage, and 11 were in the chronic stage. In practically all of the patients the initial treatment was followed by prompt relief of the pain and increased discharge, improved hearing, and amelioration of the systemic manifestations of the disease. None of the patients in the acute stage which were treated in this manner developed mastoiditis or perforation of the tympanic membrane and none of them required tympanotomy. In 9 cases mastoiditis was already present when the treatment was instituted, and 2 of these later required mastoidectomy. In the chronic cases of otitis media the symptoms of persistent aural discharge, pain, tinnitus, and deafness were either diminished or eradicated, and the healing of perforated tympanic membranes seemed to be accelerated. The factors used were from 100 to 110 kv.; 16-inch skin target disease; 2 mm. aluminum filter; 5 ma., and a dosage of 71.5 roentgen units. The treatments were administered at three-day intervals and in the acute cases no more than 3 treatments were required. In the chronic cases the treatments were given at weekly intervals. In a controlled series of 25 unselected cases of acute and chronic otitis media in which roentgen therapy was not applied, perforation of the tympanic membrane occurred in 5, mastoiditis developed in 9, mastoidectomy had to be done in 5, and tympanotomy was done in 11. Lucinian concludes that roentgen therapy, when properly applied, is the treatment of choice in both acute and chronic otitis media as it shortens the course of the disease and prevents ensuing complications.

Levin (15) reports favorably on the value of roentgen treatment of acute inflammatory conditions in children, particularly acute lymphadenitis and early mastoiditis. He emphasizes that the value of the rays is greater when used early in the course of the disease and states that the treatment should be given by a competent therapeutic radiologist. He has seen no harmful effects resulting from its use in these conditions.

Comment. From a perusal of the foregoing articles the physician is impressed with the variety and multiplicity of infectious states which are amenable to roentgen-ray therapy. Indeed it may be said that in the presence of infection anywhere

in the body, particularly the acute variety, irradiation treatment is at least worthy of a trial. In infections around the face, in early localized erysipelas, in furuncles, in granulomas and infected hemangiomas, in parotitis, and in certain types of cellulitis and lymphangitis, roentgen-ray therapy should be regarded as the treatment of choice. It offers much in the way of lowering the mortality rate in pneumonia. All of those familiar with its use emphasize its curative and healing properties when it is applied early in the course of the infection. With this thought in mind it should not be prescribed merely as a last resort after all other remedies have been tried and found wanting. The logical time to employ this valuable adjunct in combating infection is when hyperemia, leucocytic infiltration, and other inflammatory phenomena are beginning to appear. At this time the infection itself is not well established and hence an added reinforcement of the body's defense mechanism by means of irradiation therapy may abort the inflammatory process by overwhelming the invading micro-organisms. To secure such a happy result calls for close cooperation between the surgeon or physician and the radiologist, as only this will lead to the best results that can be expected. In the hands of the skilled radiologist such a form of therapy is harmless to the patient, and no untoward effects have resulted from its use. With the almost universal adoption of the "r unit" as a measure of quantity of radiation and a better understanding of the proper choice of filters, it is now possible to duplicate the doses of irradiation which have been found to constitute the optimum in various inflammatory conditions. With a better appreciation of its merits on the part of the medical profession, and its more universal administration by radiologists in general, roentgen-ray therapy will rightfully take its place as one of the first-line measures of defense in the proper treatment of infections.

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PHYSICOCHEMICAL METHODS IN SURGERY

ROENTGENOLOGY

Kieffer, J.: The Laminagraph and Its Variations. *Am. J. Roentgenol.*, 1938, 39: 497.

The laminagraph is a device embodying the principle of roentgenographic body sectioning. Its fundamental principle is that the tube and film move during exposure in such a way that the roentgenographic shadow of a selected plane in a body remains stationary on the moving film while the shadows of all other planes have a relative displacement on the film, and are therefore blurred in varying amounts, depending mainly on the distance of such planes from the one selected. A brief historical review of the development of apparatus of this type is given by the author. Diagrammatic illustrations portray both how its objective is attained and some of the advantages it offers when desired parts are obscured by superimposed dense structures as revealed by ordinary roentgenography.

Various factors, such as the character of the movement used, the amplitude of the motion, and the distance of the target and film from the plane visualized, affect the nature and amount of blurring and consequently the practical value of the method. All of these are discussed at some length. How the various problems are met by the laminagraph devised by the author is described in detail. The advantages and disadvantages of various techniques for different clinical applications are also given due consideration. Devices for stereoscopic laminagraphs and elimination of secondary radiation incorporated in the equipment add greatly to its usefulness.

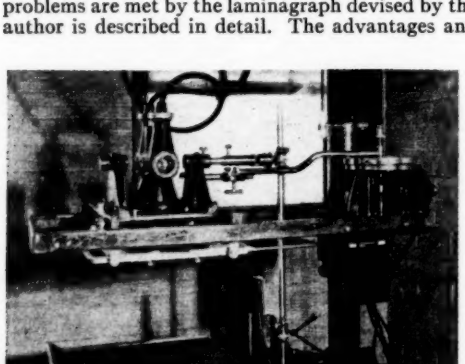


Fig. 1. A close-up of the mechanism of a laminagraph. The tube supporting structure, actuating turntable, and motor are shown. The plane to be visualized is selected by adjusting the pivot (arrow) of the rigid rod without changing the target-film distance or moving the patient. The adjustable diaphragm under the tube support limits the roentgen-ray beam and keeps it centered in one direction, while a similar diaphragm (not shown) on the rocking tube cradle limits the beam and keeps it centered in the other, giving a combined effect similar to that of a cone kept oriented toward the center of the object plane at all times.

Theoretical analysis has disclosed future possibilities which have not yet been practically tested. It is possible to obtain roentgenographic visualization of planes at right angle to the long axis of the body, so-called "transverse" or "frontal" sections, for instance, sectional roentgenograms of the spine through, or parallel to, the vertebral discs with the body in normal position; sections parallel to the floor of the skull; and cross sections of long bones. Roentgenographic cross sections of the body at any level and at any angle desired, no matter how extensive may be the longest dimension of the body, are another possibility. Roentgenographic application and even cine-plani-roentgenoscopy are entirely feasible. How these possibilities may be realized is discussed and illustrated diagrammatically.

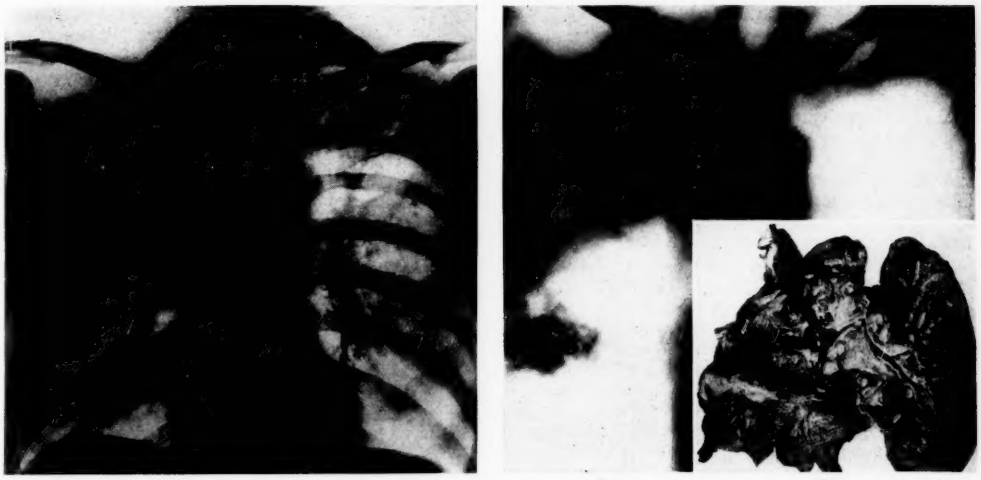
Further consideration of theoretical data discloses that a machine embodying the special spiral motion described has potential applications in therapy. With the parabolic spiral used to actuate a somewhat modified linkage system it becomes possible to focus a large amount of radiation in a relatively small field in the body while it is spread fairly evenly through a very large portal of entry, and thereby markedly diminish the effect on normal tissues as compared with the effect on the abnormal tissues which it is desired to treat. ADOLPH HARTUNG, M.D.

Moore, S.: Body Section Roentgenography with Laminagraph. *Am. J. Roentgenol.*, 1938, 39: 514.

Body section roentgenography serves to overcome the difficulty of separating superimposed densities as revealed by the ordinary roentgenogram. It does this by "focusing" on a particular object and removing or diminishing overlying or underlying images. The manner in which this has been accomplished by different investigators is briefly reviewed by the author. The author mentions objections to some of the terms which have been applied synonymously to the apparatus used and suggests the name of laminagraph as being preferable.

The equipment he has been using was devised by Kieffer and follows the general mathematical principles which govern all the methods so far developed. Although it can be used with a variety of movements the spiral presented advantages which led to its being used almost exclusively for clinical applications. These have been of rather limited extent, and included only examinations in the pulmonary area, the spine, and head, in 2 cases of the shoulder, and 1 of the sacro-iliac joints.

All of the pulmonary cases were examples of surgical lesions and in several of them the aid supplied



A. B. C.

Fig. 1. A. Conventional roentgenogram of chest. Area of consolidation. Arrow indicates faintly marked dark area. B. Laminagram of preceding; cavity clearly shown. Partial cautery pneumonectomy. Death from sepsis. C. Photograph of lungs with extent of cavity clearly seen.

by this means as to the existence, size, location and depth of the lesion was invaluable to the surgeon. Cavitation in areas of consolidation has been discovered by this means when its presence in the standard examination was not suspected (Fig. 1).

In mediastinal lesions, the method has been useful also. In the case of the skull, the laminagraph can reveal conditions in the base of the skull which are ordinarily obscured by overlying shadows on ordinary roentgenographic exposures. It has been of invaluable service in the examination of the cervical spine, especially in the anteroposterior projection in cases of suspected trauma and tumor of the vertebræ. Also in portions of the rest of the spine the laminagraph portrayed lesions better than could be done otherwise. Of the joints of the extremities, only the shoulder has been investigated, and in both cases small avulsion fractures from the rim of the glenoid fossa of the scapula with loose fragments of bone were demonstrated when they could not be visualized by standard methods.

So far there is no evidence that the planigraphic examination of the abdominal content will supersede present methods of examination, and it remains to be demonstrated that it is of aid in the absence of a natural or artificial contrast in density. The employment of this method in conjunction with artificial contrast media, for example, the opaque meal, may at some time in the future prove to be of value, but for the moment one must regard such a possibility with a great deal of skepticism.

As regards the technique, the general principles which hold in standard roentgenography apply to planigraphy. Some details which the limited experience warrants are included and a routine examination is described. Choice of motion and consequent modification of the time of exposure are dependent on the depth of the layer to be roentgenographed and the nature of the overlying and underlying media. Normal roentgen-ray exposure should precede a planigraphic examination as it may aid greatly in predetermining the depth of the layer to be roentgenographed. There is every reason to believe that preliminary roentgenography is essential and that therefore planigraphy will not supersede, and cannot be substituted for the standard preliminary examination. ADOLPH HARTUNG, M.D.

Crowther, J. A.: The Biological Action of X-Rays; A Theoretical Review. *Brit. J. Radiol.*, 1938, 11: 132.

There has appeared in the literature since the discovery of the x-rays by Roentgen in 1895 an immense amount of material dealing with their biological effect. It is not the author's purpose to summarize all of this material but rather to discuss what light may be gleaned from this mass of experimentation on the problem as to how x-rays produce their biological effect. The action of x-rays on single cells and unicellular organisms is considered.

A striking feature of a survey of this type is the marked difference exhibited by different tissues to the action of radiation. A dose of 5 roentgens will kill half the individuals in a clutch of calliphora eggs, while a dose of 330,000 roentgens is required to destroy 50 per cent in a culture of colpidium. Only 120 roentgens are required to inhibit mitosis but 13,000 roentgens are necessary to produce even a

delayed lethal effect. Cells are more sensitive during mitosis, and rapidly dividing and undifferentiated cells are more susceptible than adult tissue. Massive doses of 100,000 roentgens and upward will kill any living material. This action is probably due to chemical changes in the cytoplasm due to the liberation of a large amount of energy in the tissues. The surprising feature is that profound biological effects can be produced in the same tissue with something like one thousandth of the lethal dose of 100,000 roentgens.

The effects produced by small doses of radiation fall into 3 categories: (1) inhibition of mitosis, (2) production of mutations, and (3) death. Since mitosis and mutation are functions of the nucleus and since death of the cell is probably due to its inability to divide, it seems probable that the effect produced is due to some action of the radiation on the nucleus. The author believes that the seat of action is not in the nucleus as a whole but in specific structures in the nucleus. The resting nucleus is comparatively insensitive to radiation, but with the onset of mitosis and the resultant structural changes which occur, the nucleus becomes sensitive to small doses of radiation. The evidence in favor of the specific action being on a gene is strong.

A beam of x-rays consists of a group or swarm of photons, the energy in each photon being proportional to the voltage. As these photons pass through matter a certain number are absorbed by the atoms and for each photon absorbed a photo-electron is ejected. The electrons ionize a minute fraction of the molecules through which they pass so that a trail of ions marks the path which they take. This process can be easily photographed. An alternative method of energy transference is the Compton scattering effect. The photo-electron absorption is effective for the longer x-rays, but the Compton effect predominates for radiation above some 120,000 volts. In either type of absorption the point to bear in mind is that the energy available ultimately becomes concentrated in a small number of atoms. The energy liberated during the passage of 100,000 roentgens through a gram of tissue amounts to about one fifth of a calorie, while the energy which can be concentrated in one molecule is enormous and amounts to some 20,000 calories per gram. The discontinuous distribution of energy in x-ray absorption must be kept in mind. If it were possible to pass x-radiation at an intensity of 1 roentgen per second through the air of an ionization chamber continuously for five hundred years we should still leave about one-third of the molecules unirradiated.

The author places the various theories of the biological action of x-rays into two main categories which he has labeled the "poison" hypothesis and the "target" hypothesis. The poison theory postulates that certain unspecified poisonous material is produced in the nucleus by radiation. The target hypothesis assumes that action takes place whenever one of the biological structures is "hit" by the radiation. There is considerable disagreement as to what constitutes a hit. Holweck and Lacassaque believe that it is the absorption of a photon in the structure, while the author suggests that a "hit" is registered when a pair of ions is produced within the sensitive particle. The ion-pair theory postulates that the sensitivity should be independent of the wave length. This independence of sensitivity has been borne out in experiments on various types of eggs.

In his discussion the author raises many questions which are difficult to explain on the basis of the poison hypothesis. Since poisons are usually applied outside of the cell it becomes difficult to compare their action with a poison which is produced inside of the cell. An increase of temperature greatly enhances the action of chemical disinfectants, but produces no alteration in the action of x-rays on various types of eggs. The bactericidal effect of a chemical disinfectant increases rapidly with the concentration, while all the evidence shows that the x-ray effect depends only on the total dose and not on the rate of administration. The author finds it very difficult to explain various survival curves on the basis of the poison theory.

These survival curves, on the other hand, can be simply and rationally explained by the target hypothesis. Particles of microscopic size have a very fair chance of escaping the effects of radiation because of the wide distances which separate the points at which the energy is concentrated. Although the experimental survival curves can be simply explained by the target theory, it is necessary to examine the assumption on which the theory rests. It is necessary to assume that there are in the cell certain structures sensitive to radiation. Numerous experimental observations strongly suggest that the x-rays act directly on the genes and not indirectly through the medium of the cytoplasm.

The experiments of Wyckoff in the killing of bacteria by ultraviolet light have been raised as an argument against the target theory. The author states that there is a very vital distinction between x-rays and ultraviolet light. The energy of x-radiation is measured in thousands of volts while that of ultraviolet light used by Wyckoff is only 4.7 volts. Since the energy needed to produce a pair of ions lies between 6 and 10 volts, it would appear that a single quantum of this radiation could not, by itself, produce any ionization. Where it was possible to study cumulative ionization experimentally, the absorption of many photons was necessary for the production of a single pair of ions. The number of hits will be far fewer than the number of photons absorbed. The efficiency is probably not greater than 0.1 per cent.

If it can be shown that the action of x-rays is a direct action on certain minute biological units, and as the only direct effect is the production of ionization, the biological effect must be the result of ionization. Anything further than this must be speculation as it is improbable that the nature of life can be discovered by physicochemical experi-

ments. The results of x-ray analysis cause considerable doubt as to whether the inception of a molecule has much real meaning in the solid state. Marked changes in biological properties have been brought about in complicated molecules by a very slight change in the constituent groups. The energy corresponding to a pair of ions is adequate to provide the energy necessary for any chemical reaction.

The inclination of the author is to seek a solution in terms of electrical charges. The change in structure which appears when a cell goes into mitosis is not dissimilar to the coagulation of colloid particles. Since the balance between the differentiated and homogeneous phases of the nucleus must be a delicate one, it is conceivable that an artificially induced change in the charge might easily delay the onset of the process, and give use to mitotic delay; or disorganize the normal processes, and give use to gene mutation. The author and fellow workers have shown also that it is possible to change the electrokinetic potential of a colloid as much as 10 per cent with a dose of only 20 roentgens. Changes of this magnitude in the colloidal constituents of the nucleus could hardly fail to produce marked biological effects. EARL E. BARTH, M.D.

Renander, A.: The Radiological Treatment of Actinomycosis (Le traitement radiologique de l'actinomycose). *Acta radiol.*, 1937, Supp. 35.

This is a complete historical account of our knowledge of actinomycosis, its localization, and various methods of treatment, especially with potassium iodide. Reference is made to the first treatment with x-rays carried out by Bevan, who in 1905 described 6 cases of actinomycosis which he had managed with success by means of roentgen rays. Following his first work Bevan and a number of others reported favorable results, the most important and the most recent report being that of Forssell and his colleagues in Stockholm, who between 1915 and 1932 treated 52 verified cases of actinomycosis. Of these, 31 were cervicofacial, 13 abdominal, and the remainder genital, thoracic, cutaneous, or with an undetermined origin.

The technique of Forssell and his colleagues was as follows: Treatments were given in series with intervals of from six to eight weeks. In each series the patient received every day, or every other day, up to 1 skin erythema dose on each skin field. At each treatment the superficial dose varied somewhat, most often averaging between one-sixth and one-third of a skin dose. Fractionated treatment was found to provoke less pronounced symptoms of local reaction than strong doses. Radium treatment was also employed in some cases but in the form of a radium bomb or radium cannon, in which 3 gm. of radium were used at a distance from the skin simulating the effect of penetrating x-rays. Generally the distance was 5 cm. Radium was always used in connection with the x-rays. Cure was obtained in 83 per cent of the cervicofacial lesions, and in 38.5 per cent of the abdominal cases. None of the patients with genital or thoracic lesions survived, and only 1 of the 2 with cutaneous lesions survived. As to the effect of the potassium iodide alone or in combination with radiological treatment, the author could not draw any certain conclusions. He was not able to determine any difference in the rapidity of cure in cases in which potassium iodide was not prescribed.

JAMES T. CASE, M.D.

MISCELLANEOUS

CLINICAL ENTITIES—GENERAL PHYSIOLOGICAL CONDITIONS

McKirdie, M.: Pilonidal Sinus. *Ann. Surg.*, 1938, 107: 389.

During a period of eleven years, the author has observed 96 patients with a condition which has been diagnosed as pilonidal sinus. Several of these patients have been treated twice or oftener for recurrence of the original condition, which makes a total of 113 instances. Although many newborn infants and children show a dimpling or depression over the sacrococcygeal region, nevertheless the presence of a true sinus tract in adults is limited to about 3 or 4 per cent of the population. Males show a considerable predominance among the cases of this condition, and most of the patients are in the third decade.

The theories of origin are concerned mainly as to whether the cyst or sinus arises from the neurenteric canal, or is the result of ectodermal invagination. The authors believe that clinical and experimental evidence lends more support to the former theory. The pathology and symptomatology in the average case are similar to those of a chronic inflammatory process which has undergone an acute phase, with periods of chronicity and subsequent exacerbations.

Treatment consists essentially in the complete eradication of the sinus tract without the sacrifice of any more normal tissue than is necessary. McKirdie believes that the injection of the sinus with methylene blue is conducive to a false sense of security and the needless sacrifice of normal tissue.

Recurrences are frequent and are due to several factors; namely, failure to remove the sinus tract; operation for excision in the face of acute infection; poor hemostasis; and dead space with subsequent hemorrhage and infection. JACOB M. MORA, M.D.

Rogers, H., and Dwight, R. W.: Pilonidal Sinus. *Ann. Surg.*, 1938, 107: 400.

The authors report a series of 140 cases of pilonidal sinus which were all treated by cautery excision and open packing. The ratio of males to females was 3 to 1. In over 400 cases Rogers and Dwight have not seen a sinus communicating with the neural canal, and they believe that roentgenographic examination after the injection of iodized oil is superfluous except in markedly atypical cases. Neither have the authors noted any extension of the sinuses into the sacral hiatus, sacrococcygeal joint, or beneath the sacral aponeurosis.

Two essentials are necessary for cure: adequate removal of the diseased tissue, and solid healing of the wound. Because of unavoidable obstacles to sound healing by first intention, the authors believe that open packing and healing by second intention will produce the highest percentage of cures in unselected cases. In selected cases it may still be desirable to incur the greater risk of failure associated with primary closure for the sake of shortening the treatment in those cases which terminate successfully.

JACOB M. MORA, M.D.

Cutting, R. A., Lands, A. M., and Larson, P. S.: Distribution and Excretion of Water and Chloridee After Massive Saline Infusions: An Experimental Study. *Arch. Surg.*, 1938, 36: 586.

The experiments reported in this communication were designed to determine the maximum rate of infusion of an essentially isotonic solution of sodium chloride compatible with survival, and the lethal dose. It was also proposed to find out the cause of death after such lethal infusions and to trace the intermediate assimilation, translocation, and excretion of both the sodium chloride and the water when given in just sublethal amounts.

Using cats as the experimental animals in this work, the authors came to the following conclusions:

The lethal value for infusions of a 1 per cent solution of sodium chloride in cats is 500 c.cm. per kgm. of body weight when the rate of injection is 5 c.cm. per kgm. of body weight per minute. In a man weighing 154 pounds or 70 kgm., this would correspond to 35 liters at a rate of 350 c.cm. per minute. Hypertonic solutions are lethal in smaller bulk and at slower rates of infusion.

During such massive infusions the blood pressure is neither greatly nor constantly affected. Vasodilatation and, particularly, diffusion of the solution into the tissue spaces serve to stabilize the blood pressure at an essentially normal level. At the time of death the blood pressure abruptly declines.

The important changes observed at autopsy are: (a) evidences of watery vomiting and purging; (b) swelling of the entire animal, especially of the abdomen; (c) the presence of a considerable amount of free fluid in the abdominal cavity; (d) edematous thickening of the stomach, the colon, and the urinary bladder; (e) gelatinous edema of the pancreas, the space between the leaves of the mesentery and the retroperitoneal space; and (f) edema of the lungs and the salivary glands.

Unless pushed to a rather sharp end-point of decompensation at which the blood pressure rapidly declines, infusions are not incompatible with rapid and complete recovery. The sharp end-point is believed to represent some physiochemical imbalance rather than failure of any particular organ or system. Accidental death will occur in perhaps half of the cases before any considerable amount of solution has been infused if precautions are not taken to prevent regurgitation, aspiration of the regurgitated material, and ultimate drowning of the animal in its own vomitus. Pyrogenic substances contaminating the water used in compounding infusions may account for some premature deaths.

The relative weights of the various organs and tissues of the body and the water content of these tissues and organs are comparable to those in man specifically when the cat is used in the laboratory. Experiments on the translocation of water following the administration of large intravenous infusions in the lower animals should therefore presumably be comparable with what occurs in man under similar conditions.

During and after a massive infusion both the water and the salt tend to leave the blood stream rapidly; they accumulate presumably in the tissue spaces. Relatively little water can be accommodated in such closely knit organs as the muscles and the skin, although because of their bulk their actual capacity for storage is considerable. Presumably the salt contained in the water thus stored is in essentially isotonic concentration. Organs, such as the alimentary tract (except the duodenum), the salivary glands, and the lungs, which act to some extent as natural water emunctories, seem to store water differently. They probably do not store it passively in their tissue spaces as in the case of the organs previously mentioned, but actively within their parenchymatous cells, where they are preparing it for excretion. Accordingly, analyses show that the duodenum, muscle, the spleen, and skin store sodium chloride and water in the proper proportions to make a 1 per cent solution. The liver, lungs, kidneys, pancreas, stomach, colon, and salivary glands, all organs concerned with the elimination of water, store water considerably in excess of the amount necessary to make a 1 per cent solution with their contained sodium chloride.

The cerebrum is the one tissue in the body which stores no water, though it seems to store some salt. Cerebral edema definitely does not occur after massive infusions of 1 per cent solution of sodium chloride and therefore cannot be the cause of death when the limits of toleration are exceeded.

Even during the course of the actual infusion of a massive quantity of 1 per cent solution of sodium chloride the kidneys eliminate a considerable amount of both the water and the salt. Before the infusion of this solution is complete nearly 20 per cent of both the water and the salt has been eliminated by the kidneys.

The amount of salt and water stored in the tissues, amounting to approximately 80 per cent of the total body weight, for which analyses were available, and the amount eliminated by the kidneys during the infusion equal about half of the total amount infused. The remaining half must have been stored in tissues constituting not more than 20 per cent of the total body weight. The most logical conclusion, in view of the spectacular gelatinous edema which was seen in the loose areolar connective tissues about the pancreas and in the retroperitoneal space, is that enormous quantities of water and salt are probably stored in these and other loose, areolar connective tissues throughout the body. These tissues, for obvious reasons, were not collected for analysis.

Within twenty-four hours after the administration of a just sublethal massive infusion of 1 per cent solution of sodium chloride all of the salt and about 80 per cent of the water have been eliminated by the kidneys. The rate of elimination is variable from hour to hour.

JOHN H. GARLOCK, M.D.

Uggeri, C.: The Xanthoprotein Reaction in Surgical Conditions (La reazione xanthoproteica nelle affezioni chirurgiche). *Clin. chir.*, 1938, 14: 103.

After the first publication by Becher on the technique and importance of the xanthoprotein reaction, especially of the blood serum, numerous publications have appeared on this subject. There is a review of the technical literature on this subject.

There have been conflicting reports on its significance. The author describes the technique he used. He uses Oefelein's value of 30, as the normal figure; this was based on 10,000 determinations.

The author performed 191 determinations in 124 patients. His series included a variety of conditions, such as diseases of the biliary tract and prostate, neoplasm, renal tuberculosis, and intestinal occlusion.

The author is quite conservative about the significance of this reaction and deprecates too much trust in the test as a criterion of operability. In general surgical conditions mild elevations of the xanthoprotein reaction occurred which were of dubious significance. The most definite elevations occurred in renal conditions, diseases of the liver and biliary tract, and in intestinal occlusion. In renal conditions the elevation in the xanthoprotein reaction occurred in irreversible types of uremia. In these cases the xanthoprotein reaction was of grave significance as to life.

In general, it is not advisable to rely on the xanthoprotein reaction when it comes to deciding such serious questions as indications and contraindications for surgery, as well as prognoses.

JACOB E. KLEIN, M.D.

Sorce, G.: The Action of Ethereal Splenic Extracts upon the Healing of Wounds (Azione degli estratti eterei splenici sul processo di guarigione delle ferite). *Arch. ital. di chir.*, 1938, 48: 228.

Sorce reviews briefly the various methods which have been employed to induce rapid healing of aseptic wounds by second intention. These methods are generally based upon the local application of chemical, physical, electrical, or biological agents.

The most commonly employed chemical substances are a 5 per cent solution of sodium chloride and sodium citrate, magnesium sulfate and glycerine, hypertonic solutions of sodium sulfate, and calcium chloride.

Several investigators have also studied the action of oxygen and of the halogen salts of calcium and magnesium. The stimulating action of the aniline derivatives and of coal tar has also been subjected to extensive study and research.

Biological methods include such procedures as transplants, periarterial sympathectomy, and the

application of various sera, hormones, or vitamins. Recently the favorable effect of cod-liver oil has also been studied by several authors.

In the present study Sorce wishes to report the favorable effects upon wound healing obtained from the parenteral administration and local application of ethereal splenic extracts. Earlier studies revealed that these extracts when given intravenously to rabbits stimulate the parenchymatous portions of the reticulohistiocytic system.

Rabbits were used as experimental animals and the wounds were produced artificially by excising portions of the skin to the level of the muscular layers under strictly aseptic conditions. The speed of wound healing was studied in two groups of animals. In one group the splenic extracts were administered intravenously, whereas in the other group the extract was applied locally.

The results obtained from this experiment showed that the administration of ethereal splenic extracts emulsified in physiological solution accelerates wound healing in rabbits, especially if the extracts are administered intravenously.

Post-mortem examination of animals treated over long periods of time with these extracts reveals changes especially in the spleen and bone marrow. The spleen shows a thickening of its capsule and of the splenic reticulum. The number of histiocytes in the follicles is increased and the latter are markedly hypoplastic. In animals treated over long periods of time the lymphoid tissue is found to have become progressively aplastic. The adventitia of the blood vessels is thickened throughout.

In the bone marrow the myeloid elements are aplastic and there is an increase of cellular elements of the megacaryocytic series. The medullary portions show atrophy and fibrosis.

On the basis of these findings the author concludes that the rapid healing of wounds is to be attributed to the stimulating action of the splenic lipoids upon the reticulohistiocytic system.

RICHARD E. SOMMA, M.D.

Cramer, W.: On the Origin of Cancer. *Brit. M. J.*, 1938, 1: 829.

The frequency of cancer increases rapidly as age advances, and its death rate increases in almost geometrical progression with the decades.

All carcinogenic stimuli and agents, such as chemical substances, physical agents, and even gross parasites, have in common the characteristic that they induce cancer only after a lapse of time occupying a considerable fraction of the normal span of life. The period of induction is characteristic for each species, and is much more prolonged with a weak carcinogenic agent than with a very active one. During the prolonged action of these carcinogenic agents, the tissue on which they act undergoes pathological changes and then cancer arises within this altered, or precancerous, tissue. That the preceding existence of such precancerous conditions is not generally recognized is due to the fact that these conditions need not be sufficiently severe to manifest themselves as a definite disease.

There are thus two phases in the development of cancer: (1) a preliminary phase, or "the origin of cancer" and (2) the second phase, or "the growth of cancer." The preliminary phase extends over a long period of years, a considerable fraction of the span of life: therefore we have the characteristic age incidence of cancer. This phase culminates in the sudden transformation of a few normal cells into malignant ones. The development of this precancerous condition depends upon the action from without, of agencies of the most diverse nature, on the cells of a given tissue. When a cell within a precancerous area undergoes transformation into a malignant cell, a change occurs within the cell which confers upon it the biological behavior characteristic of malignant cells, i.e., autonomous growth. In the second phase, there is thus produced a new race of cells, which multiply slowly or rapidly, but always without regard to the physiological needs of the tissue in which they have arisen, and without regard to the physiological boundaries imposed after the growth of normal cells. By their destructive autonomous growth they kill the organism in which they have arisen. Whatever it is that drives the cancer cell on in its autonomous growth must reside within the cell itself, and that intracellular change is irreversible.

The application of carcinogenic materials does not always produce malignant tumors. The effect of the agents is heavily conditioned by factors residing within the organism, or the susceptibility, and it is this susceptibility, or tendency to respond with the development of cancer to carcinogenic influences, which is inherited.

The recognition of cancer in man as essentially a preventable disease is based on the correct interpretation of the well-known characteristic age incidence of cancer, namely, that the onset of cancer is always preceded by a long period of induction, occupying a considerable fraction of the life span of the species, during which the tissue involved undergoes definite pathological changes. The origin of cancer can, therefore, be found by identification of the pathological changes which precede the onset of cancer and their causes.

SAMUEL KAHN, M.D.